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"The State of the Art - Ginning in the Next Decade"

Proceedings of the
conference on cotton gin technology
sponsored by the
Texas Cotton Ginners' Association
April 9, 1986 / Lubbock, Texas

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THE STATE OF THE ART - GINNING IN THE NEXT DECADE
A Technical Conference for the Texas Cotton Ginners' Association Convention
April 9, 1986 at the KoKo Palace, 50th and Avenue Q, in Lubbock

10:00 - Introduction - Roy Baker, conference chairman

Welcome by J.O. Williams, President
Texas Cotton Ginners' Association

- "New Ways to Dry Cotton" - Ed Hughs, Research Director
  USDA ARS Southwestern Ginning Research Laboratory
- "Research on barky cotton" - Roy Baker, Research Director
  USDA ARS Cotton Production and Processing Unit, Lubbock
- Harvesting developments - Alan Brashears, engineer
  USDA ARS Cotton Production and Processing Unit, Lubbock
- Gin stand developments - Dr. Lambert Wilkes, engineer
  Texas A&MU Agricultural Engineering Department
- Electric power from gin trash - Dr. Wayne LaPori, engineer
  Texas A&MU Agricultural Engineering Department

11:40 - Lunch

12:20 - Quality demands on ginned cotton
C. Carl Cox, Director, Moderator,
Natural Fibers & Food Protein Commission
Mill requirements - Jim King, Cone Mills
Market requirements - Raymond Cooper, Cooper, Volkart, Taylor

Afternoon session - R.T. Bob Newton, Vice President
Texas Cotton Ginners' Association

1:15 - Resolving gin problems by innovation - Doug Moses, Moderator, Wharton

- Product liability insurance - Raymond Adams, Bush Hog/Continental
- Quality measurements - Donald Van Doorn, Lummus Industries

- Gin stands by Bob Faris, Elbow Gin
- Labor training by T.J. Taylor, Associated Growers Gin
- The woman manager by Phyllis Moore, Progresso Coop Gin
- Making gin records pay by Jerry Webb, Long S Gin

- Computerized gin trouble shooter - Wayne Supak, TAMU engineering student

2:30 - Afternoon break

2:45 - Ginning Industry Developments - Gene Beck, Moderator, Lubbock

- Multi-saw lint cleaning - Russell Sutton, Horn Gin Machinery

- Cottonseed cleaning - Bob Stanley, Murray-Carver

- Burners - Sam Jackson, Samuel Jackson Mfg.

- UD press for small gins - James Renfroe, Bush Hog/Continental

3:30 - Review of afternoon session

3:45 - Presentation of participation certificates, adjourn

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NEW WAYS TO DRY COTTON AND MEASURE MOISTURE

By S.E. Hughs, Agricultural Engineer, USDA-ARS
Southwestern Cotton Ginning Research Laboratory
Stanley Anthony, Agricultural Engineer, USDA-ARS
Stoneville, MS, Cotton Ginning Research Laboratory
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South Plains Cotton Ginning Research Laboratory
Bob Curley, Agricultural Engineer, UofC, Davis
Don Osias, Engineer, Applied Instrumentation

INTRODUCTION

Cotton moisture content from harvest through ginning has a great effect on cotton lint quality in the bale. Storing seed cotton at too high a moisture content can lower grade, spinning qualities and seed viability (1). However, seed cotton that is below 12-percent moisture content can be stored indefinitely without any quality degradation.

Seed cotton whose lint moisture is above 8 percent must be dried for efficient gin processing. However, drying with excessively high temperatures is suspected of causing fiber to become brittle and may even cause irreversible chemical changes to the fiber (2). It is desirable that drying air temperatures be between 160 and 225 degrees F. However, many ginners feel that for seed cotton that exceeds 12-percent moisture content, a tower dryer has too short an exposure time at these temperatures for adequate drying. As a result, multiple tower dryers have come into common use with mixpoint temperatures that sometimes reach 350 degrees F or higher.

The recommended fiber moisture content for ginning with minimum fiber damage is between 6.5 and 8 percent. Ginning below 5-percent moisture content weakens fiber causing reduced staple length, increased short fiber content below one-half inch, decreased yarn strength, and decreased appearance index (1). Also, low moisture cotton may cause processing problems such as static buildup which causes chokeups in the ginning equipment.

One problem facing cotton producers and ginners is having the means to adequately monitor and efficiently control cotton moisture content. Much is known about the effects of moisture on cotton quality, but existing means of field and gin monitoring are either too slow, highly subject to operator error, or have other problems. Another problem involves the high energy requirements of present conditioning and transport systems.

Research is going on across the cotton belt on less expensive, more energy efficient methods to condition cotton and on faster, more reliable methods to monitor cotton moisture content both in the field and in the gin. This paper is a summary report on the status and results of that work.

SEED COTTON CONDITIONING

Crossflow and Counterflow Drying Background

A modified crossflow process was the first drying system developed, patented, and used to artificially dry a bale of machine-picked cotton (3). This occurred in 1926 and was the first research accomplishment after the federal government established an engineering research program to develop practical artificial drying methods for seed cotton. Crossflow and counterflow drying never caught on in the cotton ginning industry because very early in the development of gin systems pneumatic conveying became the predominant method of cotton transport. Pneumatic transport is a very simple system and was adopted in dryers to produce concurrent flow (tower) or modified concurrent flow (big reel, jembo, thermo, trough) drying systems.

There are inherent advantages to crossflow or counterflow drying methods which include increased drying on very wet cotton and decreased energy requirements for pumping the air. Present drying methods are inadequate for drying cotton when moisture content exceeds about 12 percent or wet seeds or trash are present. Additional exposure time seems to be the best solution to this problem. Providing additional exposure time is difficult to accomplish with pneumatic transport because the travel speed is so great. Residence time in the dryer can be increased and the power required to pump the air can be greatly reduced if pneumatic transport is not used. Mechanical conveying methods allow slower transport and increased contact time between the cotton and drying air.

Crossflow System Development

The module system has made available the opportunity for the South Plains Cotton Ginning Research Laboratory to develop a crossflow drying system in conjunction with belt conveyors for moving cotton from the module into a gin. A suction unloading system does not normally have a drying function. Some ginners have converted the unloading system into a drying system by dropping the cotton from the module disperser into a hot air line. This push system still has a high power requirement because it used air to transport the cotton. However, it saves some energy because it eliminates one pneumatic circuit from the total system. A crossflow drying system using hot air on an inclined wire belt can replace two circuits -- the suction unloading and first drying systems. This replaces two high pressure, high power requirement pneumatic circuits with a low power requirement belt transport defice incorporating a low pressure, long exposure time drying function.

A crossflow dryer-belt transport system can provide a considerably longer exposure time and can be instantly stopped with a heavy cotton load with no worry about choking or restart. A belt system could be equipped with variable feed rate and speed drive controls which provide a much broader range of adjustment of the drying process than that which can be done with temperature controls on conventional gin dryers. This type of dryer can be tied into a gin system, along with a second stage of counterflow drying, with all of the drying controlled by a microprocessor. This would lend itself to an automated sensing and control system capable of handling cotton at moisture contents up to 20-percent with high energy utilization efficiency.

Preliminary Results and Discussion

Conveying: Tests have shown that the belt conveyor has the potential of handling any capacity that a gin might require, can elevate cotton as high as needed, and will fit within the space typically found in module feeder and gin plant installations.

Drying: The conveying belt runs through an enclosure where heated air can be forced either upward or downward through the seed cotton on the belt. Tests consisted of a 60-second drying time on machine-stripped seed cotton whose initial moisture content was 10.5%. Drying temperatures of 100, 170, and 240 degrees F. were used with both upward and downward air flow through the seed cotton. A push-pull system was used to control air pressure to provide a zero pressure point within the cotton on the belt. This provided accurate control of air temperature and prevented gaining or losing air thorugh the cotton inlet or outlet. Airflow rate was 18.5 c.f.m/lb seed cotton.

Table 1 gives the results of the drying tests:

Table 1. -- Moisture content reduction of machine-stripped cotton on a belt conveyor-dryer, %

	Air Direction and Temperature					
	Down			Up		
Cotton component	100	170	240	100	170	240
Seed Cotton	1.1	2.3	3.2	0.7	1.4	1.9
Seeds	0.2	1.1	1.7	0.1	0.4	0.6
Trash	0.8	3.2	4.1	1.1	1.6	2.1
Lint	3.8	4.2	5.4	1.4	3.5	4.5

Air forced downward through the seed cotton gave better drying results than air forced upward. Channels tended to form in the seed cotton with upward aeration so that all cotton was not evenly exposed to the drying air.

Considering that the initial moisture content of each seed-cotton component was around 10.5 percent, all downward aeration temperature treatments dried the lint to within or below the recommended USDA moisture range for ginning

Table 2. — Drying front progression*

Drying time, sec.	Sampling depth, in. 0	6	12	18
16	1.3	0.5	0.4	0.2
32	2.0	-	-	-
48	2.4	2.1	2.0	1.4
64	2.4	2.4	2.5	2.2

* Numbers are percentage points reduction in moisture content.

Table 2 shows the progress of the drying front through an 18-inch thick bed of seed cotton. After 64 seconds, the entire depth of seed cotton has been dried to approximately the same moisture content. Initial air temperature was 240 degrees and air-to-cotton ratio was 18 cubic feet per minute per pound of cotton. Aeration was downward, and the initial moisture content of the machine-stripped cotton was 10.5 percent.

Possible Advantages to the Industry:

1. The 25-hp belt conveying portion of the system replaces a 200-hp suction system.
2. The drying portion of the system equivalent to a tower dryer system can be provided on a belt at much lower air pressure, replacing 120-hp fan system with 60 hp and the same Btu burner.
3. New drying processes, such as using preheat, may evolve to give better energy utilization efficiency.
4. A more flexible control of the drying process is possible, because cotton flow rate and drying air flow rate are independent.
5. A longer drying time is possible without sacrificing throughput rate.
6. Conveying cotton in a stationary condition on the belt may help reduce nepping and static electricity problems.

Counterflow System Development

Figure 1 shows a schematic of the experimental counterflow dryer model that was built at the Southwestern Cotton Ginning Research Laboratory. The dryer consists of 14 spiked cylinders, each approximately 16 inches in overall diameter and 50-inches long. These cylinders are similar in design to cylinders used in commercial 6-cylinder seed-cotton cleaners. The spiked cylinders are mounted horizontally in an enclosed chamber, and, in relation to Figure 1, rotated counter-clockwise at 500 r.p.m.

Seed cotton is fed into the dryer through a vacuum-dropper at the right end of the experimental dryer. The rotating cylinders move the seed cotton through the dryer and into a collection box. Heated air enters the dryer on the left and moves through the dryer against the seed-cotton flow and exits out the right. Flow retarding plates are mounted above the cylinders from the roof of the dryer. These plates are used to retard the flow of seed cotton through the dryer which increases the seed-cotton's exposure time to drying air.

Several preliminary trials were made to determine what range of air flow rates and temperatures to use. An average air flow rate of 4400 c.f.m. was selected with air temperatures of 150 and 200 degrees F.

Experimental Dryer Performance

A total of 16 random test runs were made using seed cotton whose moisture content varied between 13.0- and 17.5 percent dry base. Eight runs were at an air inlet temperature of 150 degrees F. and eight at 200 degrees F. The cotton was fed into the experimental dryer at 2 pounds per second for approximately 30 seconds. Initial and final cotton fiber moistures were determined.

In all 16 tests, the seed cotton was in the dryer approximately 14 seconds and traveled 20 feet against an airstream moving in the opposite direction at a speed between 1100 and 1200 feet per minute. The 150 degree F. tests dried lint from an average moisture content of 14.35 to 8.14 percent, the final moisture content ranging between 8.98 and 7.68 percent. Similarly, the 200 degree F tests dried lint from an average moisture content of 14.25 to 7.43 percent, the final moisture content ranging between 9.15 and 6.4 percent. In the 200 degree F tests, however, the final lint moisture was below 8 percent in seven of the eight tests.

Conclusions

An experimental counterflow dryer was built and tests of this unit show that a 200 degree F. air stream will dry the lint fraction of 13- to 17.5-percent seed cotton down to an average 7.43-percent moisture content in 14 seconds, which approaches the 7.25-percent mean of the recommended ginning range for cotton lint.

Possible Advantages to the Industry

1. The counterflow system as shown in Figure 2 has the potential of conveying, drying, and cleaning in one compact operation.
2. A possible cut in the total horsepower requirements of present seed-cotton cleaning and drying systems by 1/3 to 1/2.
3. An experimental system can be built out of machinery components that are presently being utilized so that manufacture, general adjustments, and maintenance requirements would not be greatly changed.

MOISTURE SENSING TECHNOLOGY

Field Sensing Technology

Objectives and Procedures

A field research project on moisture sensing began in 1983 by the California Cooperative Extension Services and has continued for three harvest seasons. The project was prompted by grower concern over reductions in lint grades and seed quality that have occurred in moduled cotton, particularly during late, wet harvest seasons. The objectives were: 1) to learn more about the effect of seed-cotton moisture, temperatures in the modules, and storage time on lint and seed quality, and 2) to evaluate the accuracy of meters which are used to determine the moisture content of seed cotton.

Several techniques for monitoring cotton moisture content have been evaluated. These include: 1) a hand-held seed-cotton meter which utilizes a small cup for the sample and is commonly used by growers in the field, 2) a hand-held meter design for forage which utilizes a 6-inch-diameter by 8-inch-high cylinder for the sample and doesn't have a manufacturer's calibration for cotton, 3) experimental and prototype versions of an automated unit mounted on the tramper foot of the module builder, and 4) module probes for the hand-held meter referred to in (1) above.

Results

Hand-held meters - Test results for 1983 adn 1984 have shown the forage meter to be more accurate than the hand-held seed-cotton meter for determining seed-cotton moisture. These data have been used to develop preliminary calibration charts for the forage meter for both hand-harvested and spindle-picked seed cotton. Calibration charts will also be developed from lint and seed-cotton samples that have been dried in the gin.

It should be emphasized that electrical measurements, unlike oven measurements, depend on the condition of the material being measured and to some extent on the history of the sample. For this reason, a calibration for spindle-picked seed cotton with moisture recently added by the picker (where the lint is likely to be much wetter than the seed) will not be the same as for seed cotton leaving the dryer in the gin (where the lint is likely to be much drier than the seed).

Because of the normal variability that exists in the moisture content of seed cotton, it is imperative that the sampling technique and the number of samples provide a representative average. For example, a single handful of cotton cannot be expected to provide a representative sample of the contents of a module, regardless of the moisture sensing method used.

Field tests were conducted by Salyer American during the 1985 season to compare the moisture readings on several modules by: 1) taking six samples by digging 12 to 18 inches into the module at the shoulder (at several locations around the module) and reading them in the forage meter, 2) probing the module from the side in six locations using a proble designed for the seed-cotton meter, and 3) taking six to eight oven moisture samples from various locations in the module during the building process. Data show that the forage meter results provided much closer agreement with oven moisture results than the cotton meter with a probe.

Automated meter - Information was collected during the 1983 season to determine the feasibility of mounting an automated moisture meter on a module builder. This resulted in a hand-wired prototype which was developed by Applied Instrumentation and operated on a module builder during the 1984 harvest season with excellent results. The first commercial prototype was subsequently built and operated during the 1985 harvest season. This automated meter has a moisture sensor mounted on the underside of the tramper foot on the module builder. An electronics package mounted on the top side of the tramper takes a moisture reading each time the tramper is forced down into the cotton. A pressure sensor measures the force applied to the cotton and triggers moisture readings at a constant cotton density. Each reading is sent to a microprocessor. The microprocessor converts the raw data, averages the several hundred measurements made in each module, determines the maximum moisture content, keeps track of several day's worth of modules, and can do a variety of other tasks such as ring alarms if the moisture content exceeds a predetermined upper limit.

Data collected during the 1984 harvest season showed that the average moisture content determined by the module mounted instrument agreed with the oven moisture measurements within plus-minus 0.3 percent and that the data collected by the instrument readily showed differences between one dump and the next.

Data collected during the 1985 harvest season reinforces last year' conclusions, and more sophisticated software has verified that it is possible to determine average moisture contents as well as meaningful maximums. Much of the 1985 season has, however, been spent on packaging and mechanical mounting difficulties. Excellent results were obtained in 1985 with the electronics as well as the pressure measurements. The pressure measurements were made directly on the cotton rather than by measuring oil pressure in the hydraulic line as in 1984. The original packaging proved to be too light and too difficult to mount on the module builder. A new mounting arrangement should solve the problem. Because of the time spent debugging the new version of the instrument, less data have been collected this year than had been expected.

There are some limitations with the experimental, automated unit that hope to be overcome:

1) Moisture readings aren't taken on the first 2 or 3 feet of cotton in the module because the ram is too short to compact the initial lay or cotton. This could be overcome by extending the stroke of the ram.

2) Life of the sensor plate that contacts the cotton has been shorter than expected due to abrasive wear which is probably caused by use of the tramper to move cotton in the module. The plates are inexpensive and easy to change; however, a new design is being developed that will last at least a full season.

3) The automated sensor, as currently configured, reads moistures up to the 12-percent range but does not read above 14 percent. Provision was made in the original design for a high and low moisture range. The high range is now being implemented and tested. The software within the unit will automatically switch from the more accurate low range to the high range when the moisture exceeds 14 percent.

Conclusions

It is our belief that fast, accurate measurement of seed-cotton moisture is an important part of any effort to control the effect of seed-cotton moisture on lint and seed quality. Cotton stored in modules is very susceptible to quality degradation if the moisture level is excessive.

The hand-held forage meter (when properly calibrated) and the automated meter for the module builder have the potential for improving the moisture measurement process for growers and ginners. Future work will be directed toward in-line meters for the gins and research on remote meters for bales or modules.

The field work reported here has been conducted in cooperation with Salyer American, Corcoran, California, Ranchers Cotton Oil Company, Cotton Incorporated, and California Cotton Planting Seed Distributors.

INFRARED SENSORS FOR MEASUREMENT OF COTTON MOISTURE

Methodology

A non-contact, infrared-type of moisture meter manufactured as a Model MM4 Infragauge by Infrared Engineering of Waltham, Mass. was evaluated for use in a cotton gin by the U.S. Cotton Ginning Research Laboratory (Anthony, 1985). The instrument has a "gated" capability, which means that it will not accept input from the sensor when major changes occur such as when no cotton is being viewed.

Calibration for Lint Moisture

The instrument was initially calibrated statically with seed cotton that had been conditioned over saturated salt solutions to provide atmospheres with different humidity levels (NBS Circular 512, 1951). ASTM procedure D2495 (Standard Test Method for Moisture in Cotton by Oven Drying) was used to determine the reference moisture content of each sample (ASTM Book of Standards, 1984).

Since variations in the surface texture of the cotton, the distance between the sensor and the cotton, or the glass thickness change the calibration substantially (Anthony and Griffin, 1984), those factors were held constant. The MM4 was located 8 inches from the surface of the cotton during all calibration processing and viewed the samples continuously through a 2.4-inch diameter slot cut in the wall of the feed control hopper which was covered with single-pane glass 1/8-inch thick. The sensor was installed at an angle of 20 degrees to the cotton to prevent spectral reflection.

A dynamic calibration was performed at the feed control hopper of the microgin at the Stoneville Lab. The feed control hopper in the microgin provided cotton at a depth of about 3 feet above the sensor. In commercial gins, cotton depth at this point would be at least 6 to 9 feet. The density and uniformity of the seed-cotton sample should increase with the greater depth which should improve the accuracy of the instrument.

Procedures and Results

Three separate studies were conducted -- two studies in the microgin and one study in the full-scale gin at the Stoneville laboratory. Samples for moisture were taken during gin processing, and the associated MM4 readings were taken as the seed cotton moved past the sensor at speeds of 0.7 to 2.0 feet per minute.

Study 1- Microgin Feed Control

Results were evaluated using regression analyses. The lint moisture was related to the MM4 reading by the following equation:

Lint Moisture, percent = 2.764 + 0.658 MM4

The regression model was significant at the 5-percent level. Accuracy of the MM4 was assessed by considering the standard deviations of the MM4 readings at three widely different moisture levels (Table 3). At MM4 readings of 3.2, 5.6, and 9.8, the standard deviations were 0.30, 0.35, and 0.45, respectively. This means the MM4 predicts lint moisture within approximately 0.5 percentage points by viewing bulk seed cotton which contains both lint and cottonseed.

Table 3. Comparison of representative measured and predicted values for lint moisture and seed-cotton moisture from study 1.

Variable	Actual value[1]	Predicted value	Residual	Standard error of estimate	Lower 95% confidence limit	Upper 95% confidence limit
Lint moisture	4.60	4.78	0.18	0.07	4.65	4.92
	6.50	6.49	0.04	0.01	6.40	6.58
	9.45	8.97	0.48	0.07	8.84	9.11
Seed-cotton moisture	5.10	5.16	0.06	0.13	4.89	5.43
	7.70	7.97	0.27	0.10	7.78	8.16
	14.60	13.43	1.19	0.14	13.14	13.72

1/ Values are not the means but are actual data points that were duplicated five or more times.

The seed cotton moisture for the data points shown in Figure 4 was related to the MM4 reading by the following equation:

Seed-cotton moisture, percent = 0.737 + 1.340 MM4

Analyses of variance indicate that the regression model is significant at the 1-percent probability level. Means for the three seed-cotton oven moisture levels were 5.4, 7.5, and 14.3, and their standard deviations were 0.22, 0.19, and 0.41, respectively. Means for the MM4 readings were 3.2, 5.6, and 9.8, and their standard deviations were 0.30, 0.35, and 0.45, respectively.

Study 2 - Microgin Feed Control

The instrument calibration settings were changed to agree with the results of the regression equation from study 1. After the calibraion change, means for the MM4 and oven lint moisture were 9.2 and 9.1 percent, respectively. Standard deviations were low, 0.25 and 0.22 for the MM4 and oven lint moisture, respectively.

Seed-cotton oven moisture averaged 12.2 percent for the same MM4 lint reading of 9.2 percent of above. The standard deviation was 0.30.

Study 3 - Full-scale Gin Feed Control

Two distinctly different moisture levels were considered in the full-scale gin, and the results are described separately. In the ambient-moisture, 36-bale portion of study 3, the seed-cotton oven moisture averaged 10.27 percent with a standard deviation of 0.59. The mean and standard deviation for the calculated lint moisture were 7.41 percent and 0.61, respectively. Instrument moisture readings averaged 7.50 percent, and the standard deviation was 0.33.

For the higher moisture 3-bale study, the oven lint moisture and MM4 readings averaged 8.29 and 8.45 percent, respectively.The respective standard deviations were 0.52 and 0.46. The instrument performance at these two moisture levels was comparable in the full-scale gin and microgin facilities since the standard deviations were almost equal.

An infrared-type moisture meter is suitable for use in full-scale ginning systems, but care must be exercised to ensure uniformity in the surface density of the seed cotton during calibration and gin processing. Time constants of 10 to 20 seconds will average the measurements and provide suitable readings. The meter can estimate the moisture of lint cotton by viewing the seed-cotton mass with sufficient accuracy for control of the gin drying system.

A DIGITAL CURRENT IMPEDENCE MEASUREMENT SYSTEM

Objective

Engineers at the Southwestern Cotton Ginning Research Laboratory have been working for several years to develop a contact-type moisture sensor that would be rugged enough to use on-line in a ginning system, yet sensitive and flexible enough to provide accurate seed-cotton and lint moisture readings for process control.

Project Results

Reports have been given earlier of the design and development of a microprocessor-based cotton moisture sensing system (Waldie, 1983). The system has been tested with good results on seed cotton (Waldie, et al, 1984) and cotton lint (Waldie, et al, 1983). Over a seed-cotton moisture range of 9 to 19 percent, the sensor measured the correct moisture to within plus-minus 1.1 percentage points. On ginned lint with a moisture range of 6.5 to 12 percent, the sensor measured to within plus-minus .4 percentage points of the moisture content as determined by the laboratory oven method. This performance is quite adequate to measure and control cotton moisture, provided that the sensor was presented cotton at a controlled or a known bulk density. The problem arises in that in a gin environment it is very difficult to control the bulk density of seed cotton or cotton lint. Therefore, it was necessary to develop a means of measuring the bulk density of cotton in front of the sensor plate and relating that to the sensor measurement to determine moisture content. This bulk density measurement is very important since for a given moisture, sensor response can vary by as much as 22 percent as bulk density of lint goes from 0.8 to 2.2 pounds per cubic foot (Waldie, et al, 1983).

A pneumatic bridge has been developed during the past 2 years for sensing the bulk density of either seed cotton or cotton lint. The bridge is sensitive over a range of 0.5 to 3.5 pounds per cubic foot. Several table top instruments have been built which incorporate the pneumatic bridge and the current impedence moisture sensor. Laboratory use of the instruments using varying bulk densities have shown an equivalent measurement performance for lint and the lint fraction of seed cotton as when measurements were made on controlled bulk densities. The design of the instrument is such that it can operate in the normal temperature range found in the laboratory or a commercial cotton gin. It will also self-compensate for varying ambient air pressure conditions from atmospheric to plus-minus 20 or 30 inches of water such as might be found at various places in a gin plant.

Two table-top instruments have been given to other laboratories for testing. Data will be obtained on durability, reliability, and repeatability as well as the adequacy of the current software operating system. On-line models of the sensor have been built and will be tested under actual ginning conditions for measurement response to the moisture content of cotton lint and the lint fraction of seed cotton.

REFERENCES

1. Cocke, J.B. and W.E. Garner. 1972. Effect on ginning and spinning efficiency and cotton quality of fiber moisture, seed-cotton cleaning and lint cleaning. USDA-ARS Production Research Report No. 143.
2. Stanford Research Institute. 1962. Research for Industry. Vol. 14, No. 3.
3. Bennett, C.A. 1961. Cotton ginning systems in the United States and auxiliary developments. USDA-ARS. Published by The Cotton Ginners' Journal and The Cotton Gin and Oil Mill Press. Page 56.
4. Anthony, W.S. 1985. Measurement of cotton moisture sensors. ASAE Paper No. 85-3050, St. Joseph, MI.
5. Anthony, W.S. and A.C. Griffin, Jr. 1984. Infrared techniques for estimating the moisture content of cotton during ginning. Proceedings of the 1984 Beltwide Cotton Production Conference, pp 160-162.
6. ASTM Book of Standards. Issued annually. ASTM, 1916 Race Street, Philadelphia, PA.
7. Waldie, A.H. 1983. Microprocessor-based cotton moisture sensor design and development. ASAE Publ. 9-84, Agricultural Electronics - 1983 and Beyond, ASAE, St. Joseph, MI 49085, pp 758-765.
8. Waldie, A.H., S.E. Hughs, M.N. Gillum. 1984. Electronic moisture sensor performance in commercial gin environments. Transactions of the ASAE. Vol. 27, No. 5, pp 1600-1602.
9. Waldie, A.H., S.E. Hughs, and M.N. Gillum. 1983. Automatic moisture sensor for measurement and control of ginning processes. Journal of Engineering for Industry 105:27-30.

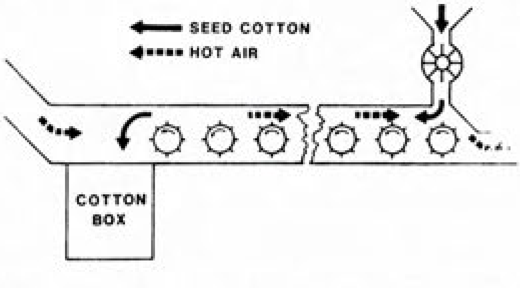

Figure 1. Experimental counterflow seed-cotton drier model.

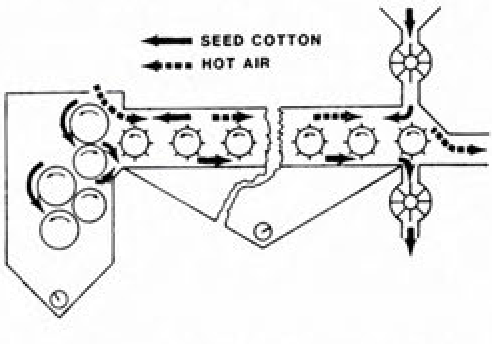

Figure 2. Proposed counterflow seed-cotton drying and cleaning system.

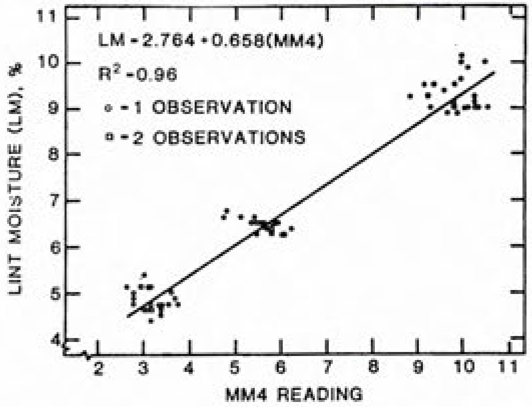

Figure 3. Actual data points plotted along the regression line for the lint moisture versus the MM4 reading. (Some coincident data points were omitted.)

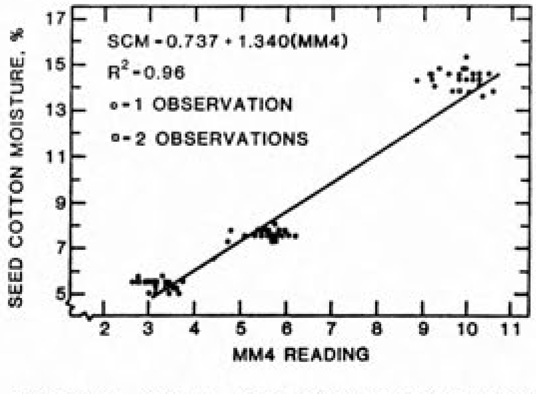

Figure 4. Actual data points plotted along the regression line for the seed-cotton moisture versus the MM4 reading. (Some coincident data points were omitted.)

GINNING TO MINIMIZE BARK PENALTIES

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INTRODUCTION

Official grade standards for U.S. cotton do not contain discernible quantities of bark. Consequently, bark in ginned lint is considered to be "extraneous matter" by the classer, and a lint sample containing appreciable amounts of bark is reduced one or more grades to reflect this special condition (10). The same rule also applies to grass, spindle twists, sand, dust, oil, parts of seeds, motes, stems, etc. The amount of cotton penalized because of excessive bark content fluctuates widely from year to year, but on the average accounts for about 20 percent of the stripper-cotton crop (14). In some years, however, it is not uncommon for over half of the crop in a given stripper area to be penalized because of bark. The bark penalty is very costly for the producer since downgraded cotton is often discounted $20 to $20 per bale in the market place. Also, some cotton spinners are concerned about possible adverse effects of bark on spinning performance and end product quality. Thus, barky cotton is a problem of considerable magnitude, particularly for those producers who use the stripper method of harvesting and bear the economic brunt of the bark problem in the market place.

Botanical identification of the bark present in lint samples has shown that most barklike strands consist of phloem fibers from the surface layers of the branches and stem of the cotton plant (9). The phloem tissue often begins to separate from the woody core of sticks and stems prior to mechanical harvesting, especially if the plant has undergone an extensive amount of weathering in the field. Bark, in this loosened condition, is easily removed from sticks and stems during harvesting, seed cotton cleaning, and ginning (8, 13). This bark material then becomes thoroughly entangled in the cotton lint. Strands of bark, being fibrous in nature, are extremely difficult to remove from the cotton by conventional cleaning techniques.

Numerous research studies have been conducted in an effort to identify ginning techniques that will eliminate or reduce the bark penalty that is so costly to producers of stripper cotton. Unfortunately, no magic cure has been found at the cotton gin. Instead, several partial remedies have been identified that will reduce the amount of bark in ginned lint, and under many conditions reduce the number of bales penalized because of excessive bark content. Also, ongoing research to fine-tune cultural practices and to improve the performances of harvesters, stick removers, and lint cleaners show considerable promise for significantly reducing the magnitude of the bark problem in the future.

STICK EXTRACTION

Harvesting and ginning research studies have shown that a close relationship exists between the stick content of cotton and the level of bark in ginned lint (8,11,12). Field conditions and harvesting practices that increase stick content of bur content generally also increase the amount of bark in the lint. While the ginner has no control over the amount of sticks present in the farmer's harvested cotton, he can control to a large extent the amount of sticks that eventually reach the gin stand. Sticks that enter the gin stand become trapped in the seed roll where they are exposed to high-speed gin saws. A large percentage of these sticks are damaged in this manner, and this action contributes to the foreign matter and bark levels in the ginned lint. This source of bark reaches a critical level when the stick content of cotton at the gin stand exceeds 1 to 3 percent by weight (8). For this reason it is important for ginners to use enough stick extraction equipment to ensure that the stick content at the gin stand is below the critical level.

Relatively low stick contents at the gin stand can usually be obtained if the gin's stick extraction equipment is capable of removing 85 to 90 percent of the sticks during the seed cotton cleaning process. A minimum of three stages of stick extraction are required to consistently obtain this level of performance. Of these three stages of extraction, the first one is by far the most important. It is desirable to remove as many sticks as possible early in the cleaning process to reduce the possibility of sticks being broken and stripped of their bark in subsequent cleaning and handling operations. The importance of this point can be illustrated by referring to the results of a cleaning study conducted at the Lubbock Ginning Laboratory a few years ago (13). In this study we evaluated two stick extraction systems. One system was composed of a bur machine, a stick machine and an extractor-feeder. We replaced the bur machine with another stick machine for the other system. Cotton from the bur machine system contained more sticks than that from the stick machine system after the first stage of extraction. Subsequent handling of the cotton apparently damaged some of the sticks and increased the amount of bark in the cotton. The loose bark content in cotton cleaned by the bur machine system was consistently higher than that in cotton cleaned by the stick machine system, and these differences were reflected in the classer's bark evaluation. Eighty-nine percent of the lint samples (after two lint cleaners) from the bur machine system and 50 percent from the stick machine system were penalized because of excessive bark (1).

Subsequent studies have shown that a relatively new combination bur/stick machine is just as effective as the conventional stick machine for removing sticks from bur cotton and slightly more effective for removing burs (4). For these reasons, and because of its durability, we recommend the combination bur/stick machine for the first stage of extraction. A modern two-saw or three-saw stick machine will adequately fulfill the requirements for the second stage of extraction. This machine is often employed directly ahead of the conveyor distributor. The third stage of stick extraction is normally provided by modern extractor-feeders that utilize the stick machine principal for stick and bur removal.

While three stages of extraction are adequate for most stripper cotton, additional extraction can be beneficial in some situations. In one of our studies we evaluated various amounts of stick extraction during tests using extremely trashy cotton. A system composed of four stages of extraction produced lint samples that graded 45 percent barky while the standard three-stage system produced samples that were all downgraded because of bark (3). Thus, the addition of another stage of extraction is an option available to the ginner and would be a wise choice if the stick contents of cotton produced in his area frequently exceed normal levels.

Generally, our research data has clearly shown that efficient stick extraction during seed cotton cleaning can help reduce bark levels in ginned lint. Efficient stick extraction, however, will not completely solve the barky cotton problem. This point can be illustrated more clearly by referring to the results of an experiment conducted several years ago at Lubbock (8). In that study we manually removed all sticks from small batches of very trashy cotton to simulate perfect stick extraction. The lint from this cotton contained less bark than that from similar cotton which had been cleaned in the normal manner, but there was still enough bark in the hand-cleaned cotton to produce the classer's penalty. These results illustrate that under many conditions enough bark can be entrained in the cotton during harvesting and handling to produce a bark penalty regardless of how well the gin's extraction system is performing.

The types of stick extraction equipment available today are generally more efficient than those available a few years ago, and improvements continue to be made. We have recently evaluated the feasibility of improving stick machine performance by using more efficient saw cylinder and grid designs, and by improving the loading characteristics of the cleaning cylinders (5). These improvements increased the operating efficiency of a stick machine by about 12 percent. Thus, there is a potential for further improvements in stick machine performance. As these and other developments are implemented, ginners can look forward to better control of stick content at the gin and to a reduction in number of barky bales.

LINT CLEANING

Even though bark is difficult to remove from ginned lint, its removal is not impossible. Conventional saw-type lint cleaners are reasonably effective in reducing the bark content of ginned lint. In several studies we manually removed and weighed the bark from lint samples collected at various locations in the gin. Samples collected before and after two stages of lint cleaning differed substantially in bark content. These results indicated that the lint cleaners removed 55 to 80 percent of the bark in the ginned lint (1,2). Despite this impressive performance, however, many of these samples still contained enough bark after lint cleaning to be penalized by the classer. These samples had been so heavily contaminated with bark in earlier processes that the lint cleaners were unable to fully rectify the bark problem.

Recent studies conducted at Lubbock during the 1980-83 crop years have provided additional evidence that lint cleaning at the gin does reduce the number of bark penalties for moderately contaminated cotton. Thirteen of the 20 test cottons studied during this period contained enough bark before lint cleaning to be penalized to some degree by the classer. Seventy-eight percent of the 385 samples collected before lint cleaning (from the 13 cottons) were penalized because of bark. The percentage of samples penalized after 1, 2 and 3 stages of lint cleaning averaged 39, 33, and 32 percent, respectively.

While the above percentages illustrate the broad average effects of lint cleaning on bark, a more detailed analysis reveals substantial differences between test cottons. Three of the test cottons from the 1981 crop year were heavily contaminated with bark, and lint cleaning did not signficantly affect bark penalties for these cottons. Over 90 percent of the samples from these cottons were penalized because of bark regardless of the amount of lint cleaning employed. Ten of the test cottons apparently contained only moderate amounts of bark after ginning. For these ten cottons, percentage bark penalties before and after 1, 2 and 3 stages of lint cleaning averaged 74, 23, 16, and 14 percent, respectively. Thus, one and two stages of lint cleaning were highly effective in reducing bark penalties for cottons containing moderate amounts of bark. The effects of the third stage of lint cleaning on bark penalties was minimal.

Several research and manufacturing groups are presently involved in research and development activities that could, in the future, improve lint cleaning processes at the cotton gin. Our research group is involved in a cooperative research project with Cotton Incorporated to evaluate the feasibility of using carding techniques at the gin to remove bark and improve lint cleaner performance (6,7). Also, we are cooperating with the ARS Cotton Quality Research Station in Clemson, SC, on research designed to evaluate various textile-type cleaning principles to determine their suitability for use at the gin. In this work we are particularly interested in techniques that remove large pieces of foreign matter such as stick fragments that contribute to the bark level of the lint. This research, and that by other research and manufacturing groups, holds a great deal of promise for achieving further reductions in the barkiness of lint from stripper harvested cotton.

SUMMARY

Efficient cleaning systems at the cotton gin are effective in reducing the number of bales downgraded because of excessive bark content. The benefits of efficient gin cleaning systems are readily apparent when processing cottons of moderate stick and bark content. For some cottons, however, the benefits of efficient cleaning may be obscured by an extremely high initial stick and bark content. In these cases enough bark is entrained in the cotton during harvesting and handling to produce a bark penalty regardless of how well the gin's cleaning system is performing. While the gin is not able to cope with these extreme cases at this time, continued research to improve stick extraction and lint cleaning systems should provide us with better tools for controlling this problem in the future. In the meantime, the ginner can make meaningful contributions to a solution of the problem by employing state-of-the-art cleaning systems and by following established guidelines for efficient, quality ginning.

LITERATURE CITED

1. Baker, R.V. 1976. Bark contamination of lint. In: 1976 Annual Rpt. USDA-ARS, South Plains Ginning Res. Lab., Lubbock, TX.
2. ----. 1977. Bark contamination of lint. In: 1977 Annual Rpt. USDA-ARS, South Plains Ginning Res. Lab., Lubbock, TX.
3. ----, E.P. Columbus, and J.W. Laird. 1977. Cleaning machine-stripped cotton for efficient ginning and maximum bale values. USDA-ARS. Tech. Bull. No. 1540 19 p.
4. ----, P.A. Boving, and J.W. Laird. 1981. Compare performances of bur and stick extractors. Ginners. J. and Yearb. 49:12-18.
5. ----, and J.W. Laird. 1982. Potentials for improving stick machine performance. Trans. of ASAE.25(1): 198-203, 209.
6. ----, and W.F. Lalor. 1984. Evaluation of a carding principle for cleaning lint at the gin. Proc. Beltwide Cotton Prod. Conf., Jan. 8-12, 1984. Atlanta, GA.
7. ----, and W.F. Lalor. 1984. Experimental dual-saw lint cleaner. Paper No. 84-3053, ASAE, St. Joseph, MI 49085.
8. Laird, J.W., and R.V. Baker. 1975. From sticks to bark. Ginners' J. and Yearb. 43:27-32.
9. Morey, P.R., D.F. Wanjura, and R.V. Baker. 1978. Identification of bark in raw cottons. Agronomy J. 70:85-91.
10. USDA. 1965. The classification of cotton. USDA, Agric. Marketing Ser., Cotton Div. Misc. Pub. No. 310. 53 p.
11. Wanjura, D.F., and R.V. Baker. 1975. Ginning of narrow-row cotton. USDA-ARS. Prod. Res. Rpt. No. 160. 9 p.
12. ----, R.V. Baker and E.B. Hudspeth. 1979. Characteristics of sticks in mechanically stripped cotton. Trans. of the ASAE. 22(2):233-236, 242.
13. ----, and R.V. Baker. 1979. Stick and bark relationships in the mechanical stripper harvesting and seed cotton cleaning system. Trans of the ASAE. 22(2):273-278, 282.
14. ----. 1979. Plant size influence on sticks in mechanically stripped cotton. Texas Agric. Exp. Station MP-1414. 8 p.

COTTON HARVESTER DEVELOPMENTS

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Cotton harvesting has developed from hand picking and hand pulling of the 1940's and 1950's to the high capacity 4 row units of today. Despite the depressed cotton economy during the mid-1980's manufacturers of cotton harvesters continue to make improvements. The early objectives of cotton harvester development was for increased harvesting efficiency and increased capacity. The trend in developments today are toward less foreign matter in the seed cotton, low maintenance for equipment and maintaining of lint quality. The harvesting of cotton ends the cultural phase and begins the processing phase where the cotton is made into usable goods. Cotton harvesting can be affected by land preparation, planting, irrigation, fertilizer, variety selection, chemicals and weather conditions. The harvesting of cotton can in turn have a significant effect on the gin and textile phases., Today's harvesters are designed to overcome these obstacles and minimize the effects of harvesting on mill processes. The following discussion is a review of recent developments in the two types of cotton harvesters, pickers and strippers.

Cotton Pickers

A recent development in commercial pickers is the power unloading system on the new Case International[2] 1844 picker. The basket is raised straight up to the desired height. A conveyor chain in the bottom of the basket unloads cotton into the module builder or trailer. This system allows the operator to have more control when unloading the basket. The cotton can be metered into the trailer or module builder rather than dumping of entire basket at one time. The manufacturers indicate reduced labor requirements are required in topping off modules or trailers and cleaner cotton due to not dumping the trash that has accumulated on top of the basket into the cotton.

John Deere will introduce an improved feature in their unloading system. The John Deere system utilizes the present dump system along with a power unloading system on the sloped side of the basket. Other improvements include larger baskets, electronic monitoring of critical systems, lighter picker bars, and automatic lubrication system for picker drums.

Research by federal and state insititutions have investigated improvements in the harvester and new production practices. The interest in producing cotton in 30-inch rows has led to the modification of picker harvesters. Valco, with the Texas Agricultural Extension Service, has shown that the 30-inch planting pattern in the Rio Grande Valley of Texas will increase yields by 15-30%. Modifications to widen wheels to 90 inches and row units to 60 inches on the picker has provided a method to pick the 30-inch rows. At the present time no commercial units can be adjusted to harvest these row spacings.

Further developments in the cultural system may allow for earlier harvest and harvesting a higher percentage of cotton at the first picking. Research in growth regulators, boll openers and defoliants may lead to a higher percentage of once over harvest for pickers.

Some problems associated with the picker include handling of the cotton volume from the 4-row pickers, high initial picker cost, black speck contamination from doffers, spindle twist and excess oil in lint.

Cotton Strippers

New developments in commercial cotton strippers include variable row spacings, a 4-row tractor mounted stripper, and the introduction of a field cleaner as original equipment. Although the 4-row unit has been around several years the unit was capable of harvesting only 3 rows in skip row (2 in - 1 out) or 2 rows for cotton planted in a 2 in - 2 out pattern. Modifications are presently available to extend the width of headers to harvest 4 rows in not only 2 in - 1 out planting patterns but 2 in - 2 out patterns. The modification also permits harvesting of 6 rows of cotton planted on 30-inch beds or 5 rows on 40-inch beds. The introduction of a 4 row (with extensions available for 5 rows) rear mounted stripper provided the producer with a high capacity tractor mounted stripper that also reduces time and effort in removing stripper from the tractor.

Field cleaners continue to create much interest although their acceptance is by only a minority of producers. John Deere has announced the availability of a factory installed field cleaner on their self-propelled units this fall. There are also two commercial companies offering field cleaners as add on units. Although the production of Deutz-Allis cotton strippers is on hold it appears favorable for its return to production in the near future. The producers' desire to deliver cleaner stripped cotton to the gin and reduce ginning costs has created considerable interest in field cleaners.

Research on cotton strippers by researchers with public institutions include improved field cleaners by engineers with the Texas Agricultural Experiment Stations and modification of stripper rolls by agricultural engineers with the USDA at Lubbock. Comparison of field cleaners, pickers and strippers have also been made.

Tommy Valco with the Texas Agricultural Extension Service compared harvest methods for 30-inch row cotton. Comparison of a modified picker, a stripper and a stripper with field cleaner found higher grade, staple and micronaire values for pickers; higher yields from pickers, and higher economic returns from strippers equipped with field cleaners and pickers.

Research at Lubbock to modify stripper rolls has found that reducing the width of paddles on an alternate brush-rubber paddle stripping roll by 1 inch would decrease bur cotton stick content by 30-40%. The reduced stick content resulted in a decrease in the number of barky grades by two thirds. Additional research is being conducted on spacing and synchronization of the stripper rolls.

Major problems presently related to cotton strippers include high foreign matter content, barky grades and maintaining lint quality from the field to mill processing.

The future of cotton harvesting will bring further changes. These changes will include higher harvesting capacity, cleaner seed cotton, and elimination of extraneous foreign material. The "barky" problem associated with cotton strippers will be minimized and higher capacity machines that exceed the handling rate of present module builders will also be developed in the future.

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[2] References to a company or trade name does not imply approval or recommendation by USDA-ARS.

GIN STAND DEVELOPMENTS

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Research is being continued on the evaluation of a new process of removing the lint cotton from the seed. This process is presently referred to as selective ginning since the concept is intended to remove the longer fibers from the seed without removing the shorter fibers that will remain on the seed. The shorter or remaining fibers are removed by a conventional saw gin after the seed cotton has been processed through the selective gin.

The laboratory model of the selective gin was developed in a cooperative project between Cotton Incorporated and the Agricultural Engineering Department of the Texas Agricultural Experiment Station (Wilkes, et.al. 1984). The gin consists of a series of 19 mm (3/4 inch) rollers mounted on the outer surface of a circular, rotating cage. Air that is drawn into the center of the cage between the cage rollers causes seed cotton to adhere to the outer surface. Lint is directed between the rollers by the air stream. Rubber covered nip rolls, positioned inside the cage and pressing on the inner surface of the cage rolls, pinches the lint and pulls it from the seed. The close spacing between the cage rollers prevents the seed from being pulled through to the interior of the cage with the lint.

The selective ginning process has been evaluated with several varieties of cotton (Wilkes, Watkins, and Lalor, 1985). The quality of the lint removed was determined by subjecting replicated samples to the standard Suter Web fiber array tests and the High Volume Instrument (HVI) classing system. The results of the data obtained with HVI showed very little difference in the properties of the lint when compared with conventional saw ginned lint. The selectively ginned lint was slightly longer and stronger. It was also more uniform. A much greater difference between the two systems of ginning was shown when comparing the data obtained in the fiber array tests. This data showed that the selectively ginned lint contained a significantly lower percent of short fiber (less than 1/2 inch) and a much larger percent of long fibers (greater than 1 inch) when compared with saw ginned cotton. The coefficient of variation was significantly lower and the mean length as well as the upper quartile length were consistently higher for selectively ginned cotton. The fiber remaining on the seed (residual) after passing through the selective gin was removed from the saw gin. This residual fiber was generally shorter than the saw ginned check in which all of the lint was removed. However, with some varieties the residual lint was generally better than the saw ginned cotton as indicated by the measurements obtained with the HVI classing system and the fiber array tests.

Procedure

Two varieties of cotton (GSA 71 and Paymaster 404) grown on the High Plains of Texas in 1984 were used for further evaluation of the selective ginning process. Both varieties were machine stripped. The harvested cotton was processed through conventional overhead cleaning machines to remove the trash from the seed cotton. Three replicated samples of seed cotton from each variety were ginned with the standard saw gin and served as a check. An equal number of samples from each variety was ginned with the selective gin. The air and nip roll pressures were set to remove about 40 to 45 percent of the lint. The residual seed cotton from each of the selective gin samples was ginned with the saw gin to remove the remaining lint. The lint obtained from each of the gin treatments (saw, selective and residual) for both varieties was processed through one lint cleaner.

Samples of lint cotton from these treatments were sent to the Textile Research Center at Lubbock, Texas for HVI classing and Suter Web fiber array analyses. Spinning tests were also conducted on samples from each of the ginning treatments at the USDA Agricultural Marketing Service, Test Section, Clemson, S.C.

Results

The effects of the selective ginning process as compared with conventional saw ginning with cotton varieties GSA 71 and Paymaster 404, as indicated by measurements obtained with the HVI classing system, are shown in Table 1. The staple length and the uniformity ratio of the lint removed by the selective gin where greater than the saw ginned cotton for both varieties. The length and uniformity were slightly lower for the residual lint for GSA 71, but approximately the same for Paymaster 404 when compared with the saw ginned lint. The most noticeable differences among the ginning treatments for both varieties were the low micronaire readings for the selectively ginned lint especially with Paymaster 404. Several tests were conducted to determine what factors may contribute to the lower values. The Shirley Fineness Maturity Test (SFMT) indicated no significant difference in micronaire, maturity or fineness among the ginning treatments for GSA 71. The results of the Sodium Hydroxide Maturity Test shows that the selectively ginned cotton to be more mature than the saw ginned and residual lint. Results from the SFMT test for the gin samples from Paymaster 404 showed the selectively ginning lint to have a lower micronaire, to be less mature, but finer than the saw ginned cotton. A similar trend was established in measuring these factors with the Goldthwait differential dye test.

The fiber properties as affected by ginning treatments and measured by the Suter Web fiber array tests are given in Table 2. The fiber lengths as indicated by the mean and upper quartile were significantly longer for the selectively ginned cotton as compared with saw ginning. The residual fiber was shorter with GSA 71, but was equal to the saw ginned cotton for Paymaster 404. Selective ginning produced more uniform fiber as indicated by the lower coefficient of variations for both varieties. The residual fiber was comparable to the saw ginned cotton in uniformity. The greatest differences among the ginning treatments for both varieties were the long and short fiber content as measured by the percent by weight of the samples. In the selectively ginned samples for GSA 71, 44.1 percent of the fibers were greater than one inch in length as compared with 34.9 percent for saw ginned cotton. Approximately 50 percent of the selectively ginned lint was greater than one inch as compared with 37.2 percent for conventional ginned Paymaster 404. The short fiber contents (percent of fibers less than one-half inch) were significantly lower for both varieties when ginned with the selective gin. The residual lint was comparable to the saw ginned lint for Paymaster 404.

Three replicated samples of lint from each ginning treatment for both varieties were subjected to spinning tests and the results are summarized in Table 3 and 4. Yarns produced with both ring and open-end spinning were analyzed. The lint was carded at the rate of 12.5 pounds per hour. With both varieties, less waste was experienced in the picking and carding operations with the selectively ginned cotton. The strength of the yarns from both spinning methods was higher with the longer and more uniform fiber that was ginned with the experimental gin. The yarns produced with the residual fiber that remained on the seed after selective ginning required only slightly less force to break the fiber when compared with conventional saw ginned lint. The number of neps contained in the yarn derived from selectively ginned GSA 71 was less than the residual or saw ginned cotton. The ginning treatment had no effects upon the neps contained in the ring spun yard, however, there were fewer neps in the open-end yarn for the selectively ginned cotton. There was little difference in the strength of the yarns between the two varieties. One major difference between the two varieties was the number of neps in the ring spun yarn.

Summary

The new ginning process in which the lint is pulled from the seed by a pinching action of two smooth surface rollers can produce lint of higher quality than the conventional saw ginning process. The lint is longer and more uniform. Results from spinning tests have shown that the strength of the yarns produced from the longer more uniform fibers are increased. There are also fewer neps in the yarn with less waste generated in the carding process. These data also indicates that the lint remaining on the seed after selective ginning is not severely affected with some varieties.

References

1. Wilkes, L.H.,K.E. Watkins, A.L. Underbrink, W.F. Lalor and J.K. Jones. 1984. A Selective Ginning Process for Cotton. Paper No. 84-3052, American Society of Agricultural Engineers.

2. Wilkes, L.H., K.E. Watkins and W.F. Lalor. 1985. A Selective Ginning Process for Cotton. Proceedings of the 1985 Beltwide Cotton Production Research Conference. PP. 341-343.

Table 1. Fiber quality as measured by HVI classing system as affected by ginning treatments with two varieties.

MEASUREMENTS	Ginning Treatment Saw	Selective	Residual
Variety - **GSA 71**			
Fineness (Mike)	3.53	3.32	3.52
Length (Inches)	.95	.97	.93
Uniformity Ratio	79.33	80.83	78.25
Strength (GM/Tex)	25.75	26.25	25.00
Variety - **Paymaster 404**			
Fineness (Mike)	3.13	2.85	3.12
Length (Inches)	.99	1.03	.99
Uniformity Ratio	78.50	79.92	78.17
Strength (GM/Tex)	25.92	25.92	26.08

Table 2. Fiber quality as determined by fiber array analysis as affected by ginning treatments with two varieties.

FIBER MEASUREMENTS	Ginning Treatment Saw	Selective	Residual
Variety - **GSA 71**			
Length (Inches)			
Mean	.84	.90	.80
Upper Quartile	1.07	1.11	1.02
Coefficient of Variation	35.84	31.17	36.65
Percent of Fiber			
Less than 1/2 inch	16.7	11.2	18.2
More than one inch	34.9	44.1	29.2
Variety - **Paymaster 404**			
Length (Inches)			
Mean	.84	.94	.85
Upper Quartile	1.10	1.17	1.10
Coefficient of Variation	38.43	33.86	38.70
Percent of Fiber			
Less than 1/2 inch	19.0	12.1	17.0
More than one inch	37.2	49.8	38.4

Table 3. Results of spinning tests for **GSA 71** variety with three ginning treatments.

YARN PROPERTIES	Ginning Treatment Saw	Selective	Residual
Carded Yarn - Ring Spinning			
Strength - 14s	177	189	170
- 22s	101	109	100
Break Factor (Avg.)	2354	2523	2289
Yarn Neps - 14s	32	20	24
- 22s	61	54	67
Carded Yarn - Open End Spinning (22s)			
Strength	57	65	52
Break Factor	1261	1423	1147
Yarn Neps	11	4	5
Waste-Percent Picker and Card	6.91	6.14	6.57

Table 4. Results of spinning tests for **Paymaster 404** variety with different ginning treatments.

YARN PROPERTIES	Ginning Treatment Saw	Selective	Residual
Carded Yarn - Ring Spinning			
Strength - 14s	184	200	182
- 22s	106	114	104
Break Factor (Avg.)	2453	2653	2418
Yarn Neps - 14s	148	150	149
- 22s	297	283	278
Carded Yarn - Open End Spinning (22s)			
Strength	66	75	63
Break Factor	1445	1650	1386
Yarn Neps	25	19	72
Waste-Percent Picker and Card	7.04	6.71	7.06

THE PRODUCT LIABILITY NIGHTMARE
by Raymond Adams
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The product liability crisis has become one of the single most important issues facing gin machinery manufacturers today and, if the present trend continues, it may become the single most important problem in managing cotton gin facilities. Product liability and other forms of general liability have indeed become a nightmare which must be better understood by businessmen in every industry, including the cotton industry. Cotton gin machinery manufacturers and cotton gin owners could easily be put out of business because of the high cost of legal defense and many run-away jury awards. Cotton farmers won't be able to grow cotton if they do not have a gin plant to process the seed cotton. Gin plants won't be able to purchase repair parts, service or new machinery if there are no companies to service and supply them with the products they need.

I recent years, most discussions and papers written on this subject have primarily concentrated on ways to reduce insurance ocsts, with some but not enough emphasis on safe working conditions for our employees. These same discussions and papers referred to the fact that the insurance crisis was forcing companies to raise prices and reminding all of us that we as consumers of products and services must eventually pay the bill for this increased cost of insurance. Whereas that may have been a fact ten years ago, it is not today.

The product liability crisis is continuing to force companies to raise prices or accept smaller profits, but now manufacturers are having to change their operations and consider elimination of certain high-risk products and services. Most smaller companies have or will soon be facing four to seven fold increases in product liability insurance. Larger companies, which could more easily absorb higher insurance costs, are facing the more serious problem of potentially not being able to purchase coverage at any price.

For example, Cessna Aircraft stopped making five types of small airplanes last year because product liability premiums had driven the prices of new models beyond the reach of most customers. Multi-million dollar judgments, multi-million dollar insurance premiums and multi-million dollar insurance deductibles can bring even the largest of companies to their knees. The ginning industry is not large enough nor profitable enough to survive if the present trend of court decisions relating to product liability and other forms of general business liability continue. This is not an old problem - it's a new problem. It has been caused primarily by a series of landmark court decisions generally agreed to have begun in 1960 and includes probably no more than fifteen court decisions over the past twenty-five years. Yet, through this series of landmark cases relating to product liability, manufacturers are now being held responsible for any injuries related to producted they introduce into commerce, no matter if the products were safe as technology allowed or were misused by their customers or customers' employees. This is entirely different from the age-old view of the common law that with few exceptions there was no liability without fault. It seems as if the judges and the juries have appointed themselves as income redistributors. Courts are supposed to resolve disputes between opposing parties, not redistribute wealth according to their idea of social justice.

I want to caution those within the cotton ginning industry that the burden and the expense of product liability exposure may soon become, and I believe it will become, a real nightmare for gin plant owners and operators. It will only take another landmark decision which holds the end users accountable to society for their misuse of the product they purchased. In California, there have been several recent attempts to do just this, and I am certain this area is fast becoming the next target of both plaintiff trial lawyers and defendant attorneys because the manufacturers can no longer afford to shoulder this burden alone.

Many have attempted to blame this crisis on the insurance companies. The insurance companies have made mistakes which they are now trying to rectify through restrictive language in insurance policies and through enormous increases in premiums and deductibles, but the insurance companies are also in business to make a profit and that is difficult to do when they cannot determine the cost of their services. In 1974, the average product liability jury award was $345,000. Last year, it was $1.07 million. It is precisely the constant modifying, altering and varying of the law that has seriously impaired the ability of insurance companies to assess the cost of providing insurance coverage.

In 1979, the Commerce Department put forth the Uniform Product Liability Act which was to be a model for product liability reform statutes to be considered by the legislatures of the fifty states and the District of Columbia. It was known at that time that this country needed more uniformity of its product liability laws. Unfortunately, although product liability reform statutes have been enacted in more than thirty states, no two states are alike, and most of them failed to address the principle issues which arise in product liability cases. If anything, there is less uniformity today than there was in 1979.

It is against this background of expanding liability, expanding damages and indeterminate science that insurers must operate. All these factors must be taken into account in deriving the premiums they must charge for their coverage. Our country must have a Federal product liability bill. I urge each of you, for your own sake, to become involved by letting your congressmen know that this is a serious problem affecting you and your business. Our modern liability system is now so standardless and it operates in such total absence of standards that numerous observers have suggested that the majority of the dollars spent winds up in the pockets of attorneys and not victims. A liability mechanism arising from the Tort System must meet three separate goals. It should provide a means of justice and equity; it should provide compensation to persons who are injured; and it should provide incentive for improvement in products and behavior. The current state of the law is such that there are few absolute standards against which behavior can be measured and that has led to a system that devotes most resources purely to the cost of litigation.

There is, however one thing <u>more important</u> than legislative reform of product liability laws. It is, in fact, the obligation of the manufacturers and the consumers of the products and services to behave in a manner that is accountable to society. By this, I mean simply that we should manufacture machines and equipment that can perform the work intended and yet be operated in a reasonably safe manner. It is also the <u>obligation</u> of the end users to install that equipment and operate it in a manner that is not unsafe for its employees. How much cotton gin machinery was operated this past year without safety guards in place? How much service work was performed on machines and equipment without it being electrically locked-out of service? How many gin crews were not provided the simple basic safety instructions necessary to warn them of hazards which might exist in the gin plant? How many machines are in the gin without proper decals warning of specific hazards which may exist? How many children or other visitors were allowed to randomly roam through a gin plant exposing themselves to potential injury while at the same time exposing the gin plant, its employees, insurers and vendors to the unnecessary risk of paying for that injury?

Enough has been said in recent years trying to relate gin plant injuries to the cost of gin plant operations. Now it is time for the manufacturers providing products and services to the ginning industry to advise our customers that they themselves are putting their own operations and financial resources in jeopardy by not adequately providing safe work conditions within their operation.

In conclusion, I would like to say that we need three things:

1. Product liability reform on the National level to provide uniform laws in all states and reform to allow us to return once again to a fair standard which will hold those responsible for the accidents accountable and not simply those that manufacturer the product. We need a court system which compensates those injured fairly and equitably , but we do not need to encourage the legal profession to sue any of us simply because they perceive it might be an easy way for them to make a good living at their profession.

2. The gin machinery manufacturers need to continue their efforts to provide instructions for the proper use and maintenance of machinery we have manufactured. This includes operational manuals, servicing instructions, warning decals and industry safety films. The users of this machinery must be certain that this information is known to their employees.

3. The owners of cotton gins must do a far better job than in the past of assuring that all machinery is guarded properly, that machinery is maintained and serviced properly, that all employees have been given safety instructions and all visitors must be either barred from entrance or escorted to assure they will not be harmed by the operation of some piece of machinery or equipment to which they are unfamiliar.

Yes, product liability is my nightmare, and I believe it could become the nightmare of all gin plant operators. The ginning associations must play a bigger role than they have in the past in communicating this message to their members. I never thought the day would come when I as a manufacturing executive could be so overwhelmingly in favor of OSHA inspectors doing their job. The ginning associations have fought to keep OSHA out of the cotton gins but, if we don't clean up our act and create safer working conditions for our employees, then I believe OSHA should play a larger role. Even our President, Ronald Reagan, who is definitely against increasing the power of the Federal Government has acknowledged the problems related to product liability because he understands how serious it is.

Finally, I hope that you have heard my message and will take positive steps to do something about the product liability crisis before it also becomes your nightmare.

QUALITY MEASUREMENTS

by D.W. Van Doorn
Lummus Industries, Inc., Columbus, GA 31994

Today's theme is "The State of the Art - Ginning in the Next Decade." But before looking into the future, let us take a brief look back over the past few decades. I think those of us who have been associated with the ginning industry can be proud of what has been accomplished.

Over the past 40 years the production capacity of cotton gins has increased about 7-fold. This has contributed to the ability to harvest cotton quickly while it is at its peak quality before it is weather damaged from remaining in the fields too long. In the past 40 years, modern ginning machinery has reduced the trash content in the lint so drastically that the grade standards for trash content have been significantly altered to reflect this improvement. Furthermore, the color and preparation of the lint have been considerably enhanced, which is rewarded handsomely by the exisiting marketing systems. Modern cotton gins also produce a bale package that is much improved over the bale packages generally produced several years ago. Bale packaging material and labor costs have also been reduced. Not only has the bale package been improved, but also the density of the bales has been increased and made more uniform. Bale warehousing, handling and transportation cost reductions from the gin to the textile mills have resulted from the improved bales. The improved bales also aid in the automation of the opening of the bales at textile mills. The present day cotton gin makes mechanical harvesting of cotton practical by removing the trash and moisture that accompany mechanical harvesting. The modern cotton gin is a much safer place to work, and it is a healthier place to work. The area surrounding the cotton gin also enjoys a cleaner environment. Automation and sophisticated controls in modern cotton gins further reduce labor and provide more consistent operation. The modern cotton gin has dramatically reduced overall labor costs.

Cotton gins have indeed made great strides in light of the economic needs presented to our industry. The economic incentives today are simply to produce the highest grades possible without an offsetting monetary loss due to shortened staple or turnout. But now let us look into the future. The theme of this meeting, "The State of the Art - Ginning in the Next Decade," is certainly a very relevant theme. All evidence indicates that we are on the threshold of some major changes in our industry that should come to fruition within the next decade. For several years now, research has been confirming that the present method of placing a value on raw lint cotton does not correlate with the true spinning value of the cotton in the textile mills. (See Fig. 1) Our present classing system places a value on lint cotton based on three factors only: grade, staple and micronaire. Micronaire is not signfiicantly influenced by the cotton gin. The current relative values placed on grade and staple create great incentives to produce the highest grade possible, even at the sacrifice of some staple. Several tests confirm that grade does not correlate well with true spinning quality of the raw cotton. Even the staple length as measured manually or by the present H.V.I. system does not reflect the overall fiber length distribution that is as important to spinning quality as the nominal staple lengths, sometimes referred to as the 2.5% span length.

Not only have these numerous tests conducted by researchers in government, the universities and private industry, substantiated the inadequacy of the present three price determining quality factors, but also the textile mill consumers are becoming more and more aware of the fact that the high grade cotton as evaluated by the current methods is not necessarily the best spinning cotton. (See Figs. 2,3,4,5 and 6)

Other raw lint quality factors have been shown to correlate better with the textile mill processibility and yarn quality than does the current major factor, grade. Short fiber content, fiber uniformity, fiber strength, neps, dust content, seed coat fragments, and very fine pin trash content are quality factors that correlate more significantly with the value of raw lint to the textile mill consumer.

New instruments to accurately measure these more significant quality factors are being introduced as a result of these tests showing the importance of these additional raw lint fiber qualities. Already we have High Volume Instrumentation systems beging installed for classing cotton. The current systems, however, do not significantly alter the classing factors that have been used for a number of years that are based on conditions that existed perhaps over 100 years ago.

We in the ginning industry can expect to have the standards of raw lint cotton measurement supplemented with additional quality measurements that will more significantly determine the true spinning value of the lint produced at the gin. We should welcome these new quality measurements as they are introduced, because they will help cotton to be more successful in the long run.

Cotton is in a critical battle with synthetic fibers that also possess excellent qualities, especially for the new high speed textile processes. Cotton's comfort and other qualities make it still the best overall fiber, but each year synthetic fibers are improved. Unless we do our utmost to produce raw lint cotton with the best true fiber quality for the textile mills, not the present "green card," cotton will slowly slip into a secondary role. None of us want to see this happen.

These new "true" quality factors will allow those of us who are gin machinery suppliers to direct our research efforts toward machinery improvements that truly benefit cotton. Presently, there are very few restraints in the raw cotton marketing system to discourage abuses of true cotton quality, at least insofar as the USDA "green card" classing is concerned. We who are attempting to serve the industry have been aware for some time that certain abuses can take place at the cotton gin that will enhance the green card class, while at the same time true spinning qualities may suffer. Because of the dominance of the monetary incentives placed on grade, excessive temperatures are sometimes use in drying. Also, to obtain the highest grades the cotton is often dried to too low a moisture content, causing a certain amount of degradation in the strength of the fiber and the length and uniformity of the fiber. Furthermore, excessive machinery, especially certain lint cleaners, will cause significant increases in neps without detection by the present classing standards.

We can expect in the next decade to have instrumentation that can detect this fiber degradation. Hopefully, premiums will be paid for cotton that has not been abused so that we in the ginning industry can direct our efforts toward improving the product we supply to our customers, the textile mills. Cotton gins in the 1990s, then, will have drying systems that will dry gently and only to the proper level for optimum true quality ginning. There will be more lint cleaners in the 1990s that will not only produce clean appearing cotton, but also cotton that is free of neps and other damage that reduces the yarn quality and processibility.

While we here today are primarily concerned with matters involving cotton gins, another major impact of the introduction of new true cotton quality factor measurements in the marketing system is that all the other segments of the industry preceding the gin will also be provided monetary incentives to cause them to bring about raw lint cotton fibers that more truly meet the needs of the textile mills. Cotton breeders will have additional incentives to develop cutlivars with fiber characteristics to optimize textile mill use. Producers, harvesting machinery suppliers, etc., will also have increased incentives to deliver to the gins seed cotton that will yield lint with higher value to the textile consumers. A large reservoir of talent that is now either misdirected or undirected will be unleashed when these new lint quality measurements are promulgated in the market place and "Ginning in the Next Decade" should undergo many changes as a result. These changes should help insure the long range success of cotton.

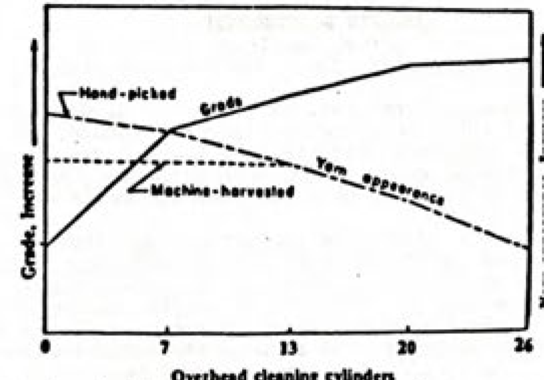
Does Cotton Price Reflect Use Value?

The price of cotton, based on spot market premiums and discounts for grade, staple, and Micronaire, reflects use value very poorly, the USDA found in a study designed to see if quality measurements can be used more effectively

by Franklin E. Newton, Samuel T. Burley, Jr., and Preston E. LaFerney[1]
U. S. Department of Agriculture

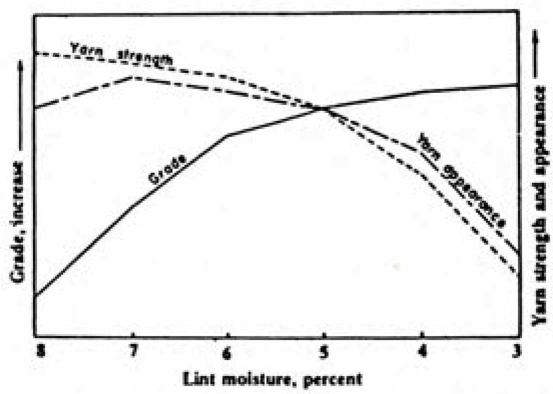
FOR MANY YEARS, cotton has been bought and sold in the mar- ... But development and evaluation of instruments require much time. ... TM) and late carded 40s yarn (0.54 TM).

FIG. 1



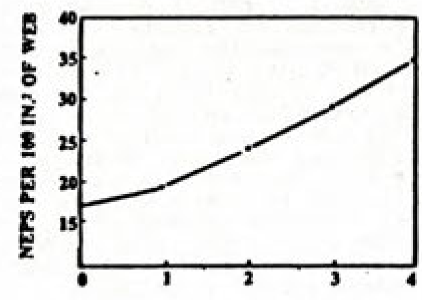
Effects of seed-cotton cleaners on lint grade and yarn appearance for hand-picked and machine picked cotton.

FIG. 4



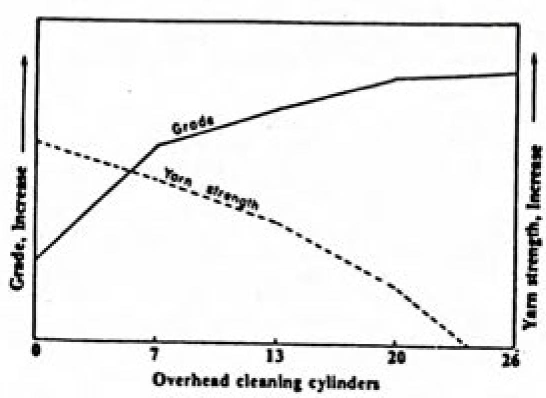
Effects of gin drying on lint grade, yarn strength, and yarn appearance

FIG. 2



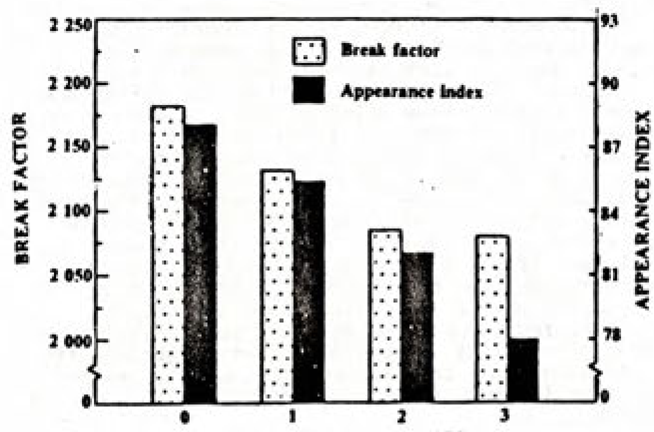
The effects of number of lint cleaning stages on neps

FIG. 5



Effect of seed-cotton cleaners on lint grade and yarn strength

FIG. 3



- *Effect of lint-cleaning stages on the average break factor (CSP) and average appearance index for the two standard yarn numbers (22s and 50s) spun.*

FIG. 6

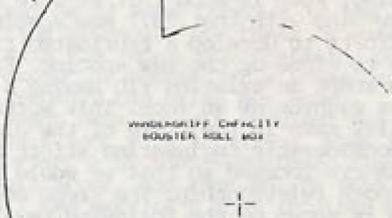
IMPROVEMENTS IN GIN STAND CAPACITY

By Bob Faris, Elbow Interprises, Visalia, California

Before the introduction of the combing lint cleaner in the 1950s, loose roll ginning was a must in order to produce a smooth sample. And a smooth sample was all important in order to avoid a price penalty. With the loose roll gin there was little that could be done to increase the per saw capacity of the gin stand. The industry was turning to more saws, higher saw speeds, larger diameter saws, closer spaced saws, etc. But significant increases in capacity could only come from higher density seed rolls which generally produced a rough "preppy" sample.

Once the combing lint cleaners came into use, we could turn up the feed, tighten the seed rolls and get some increase in capacity, and let the lint cleaners take care of the smoothness. However, we quickly encountered that old problem of getting rid of the seed at a rate consistent with the rate the lint could be removed from the seed. This is the primary reason the Vandergriff Capacity Booster Roll Box Conversion became so popular. The main feature of this conversion was the angle of the lower front section of the roll box. This steeper lower section allowed the seed roll to approach the saw at an angle of twenty degrees off vertical on all gins except the Murray, which had a ten degree approach angle.

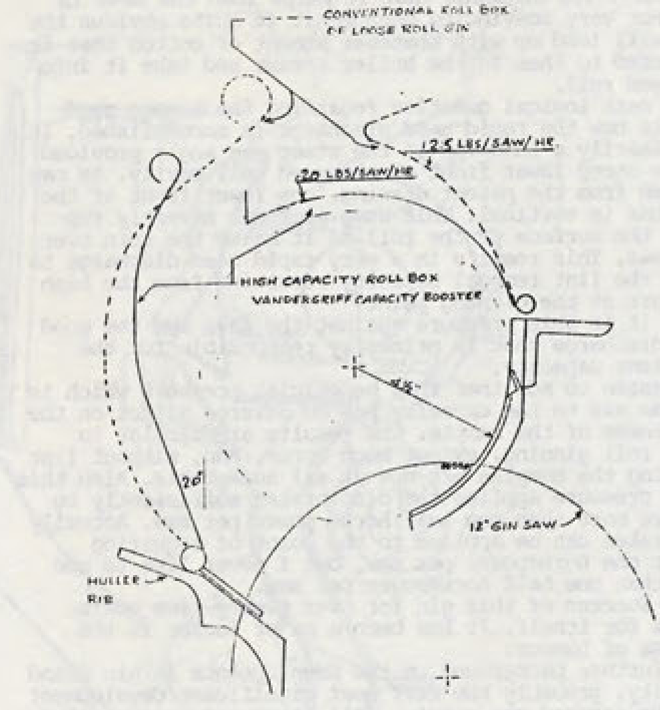
This steeper approach angle caused the seed roll to have a more drastic sag as it made the turn between the seed fingers and the gin rib. Since practically all of the seed in the roll are fully ginned except for a thin layer on the outer surface, this surface must be ruptured in order to free the ginned seed. It is this sag as the seed roll makes this turn that ruptures the surface of the seed roll and releases the ginned seed. And the more drastic this rupture, the more rapidly the seed are discharged. If the rupture is too severe, partially ginned seed may be discharged.



This roll box conversion, with its improved seed discharge, permitted the gin to operate with a tighter seed roll, which removed the lint faster, and thus increased capacity. In order to remove the lint faster it is necessary to have enough pressure to hold the seed against the saw teeth points, otherwise the seed will escape this action without being ginned, at least they will have to make more passes to get the lint removed.

I mentioned that a ten degree approach angle was used on the Murray gins. The reason for this is that the saws are spaced closer together on the Murray than other gins so a steeper angle could be used and still get clean seed at a good capacity. The Continental 120-12" Saw Gin has the widest saw spacing of any, being .787" vs. the Murray of .71875". The other manufacturers are somewhere in between, at least they were until recently when closer saw spacings came into use.

It is well known that Vandergriff was involved in the development of the Lummus High Capacity Gin with the agitator in the seed roll in the late 1950s, actively



participating in the experimental work and final development. The patent No. 3,090,001 was issued to Vandergriff and Pease.

This agitator cylinder was located only three fourths of an inch off the saw, and as the seed roll passed between the serrated discs of the agitator and the surface of the gin rib, with the saw blades projecting into the dense mass, the seed hardly had a chance to escape the action of the saw teeth. Thus the lint was readily removed from the seed. In this case the pressure against the saw was equivalent to a very dense seed roll, while the revolving powered cylinder was moving the mass over the saws. The pressure exerted in this way could not be duplicated without the rotating cylinder positioned close to the saw. Since this cylinder was made up of serrated discs set on a shaft at an angle so that, as the cylinder rotated, the discs wobbled back and forth across the saws, it is claimed that the agitator powers the seed roll, and there is little doubt that it does help the seed roll turn. But none of the explanations as to the benefit from powering the roll are very convincing. Neither is the argument that shifting the seed roll by the action of the wobbling discs presents fresh fibers to the saw, very convincing. However, there is no question about the superior capacity of the gin, but it is, as already stated, the result of the pressure of the mass against the saws at the ginning point, and the agitator a very conveninent and successful means of providing this

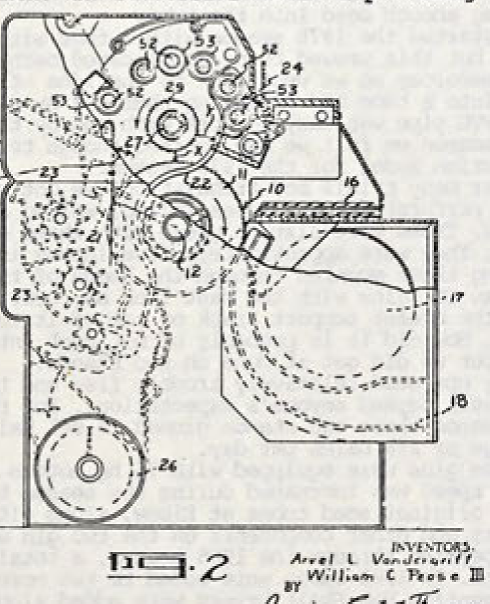


FIG. 2

INVENTORS.
Arvel L. Vandergriff
William C. Pease III
BY
Jennings Carter & Thompson
Attorneys

pressure. The argument that it helps load the saws is also not very convincing because it is quite obvious the saws will load up with whatever amount of cotton that is presented to them in the huller breast and take it into the seed roll.

The next logical question regarding the Lummus seed roll is how the rapid seed discharge is accomplished. It is primarily a function of the steep sag angle provided by the steep lower front of the seed roll cavity. As can be seen from the patent drawing, the lower front of the roll box is vertical. This step approach severely ruptures the surface of the roll as it makes the turn over the saws. This results in a very rapid seed discharge to match the lint removal capacity resulting from the high pressure at the ginning point.

So, it is this pressure against the saws and the good seed discharge that is primarily responsible for the excellent capacity.

I hasten to add that this beneficial pressure which is such an aid to the capacity has an adverse affect on the smoothness of the sample. The results are similar to tight roll ginning, except much worse. And, without lint cleaning the samples are not at all acceptable. Also this added pressure applies the disc brakes sufficiently to require more than one half horse power per saw. Actually the brakes can be applied to the point of requiring almost one horsepower per saw, but I never like to use more than one half horsepower per saw.

The success of this gin for over twenty five years speaks for itself. It has been a major factor in the success of Lummus.

As further background on the developments in gin stand capacity, probably the next most significant development was the reduced saw spacing. All gins were encountering problems with too much residual lint on the seed with the use of the normal spacing of around three fourths of an inch. While at Boswell, Vandergriff insisted that Continental Gin Co. supply a closer saw spacing for the 119 saw gins. This resulted in the 141 saw conversion and all of Boswell's gins were converted with a resulting signficant decrease in residual lint and an increase in capacity.

The advantage of the closer saw spacing spread to other companies and the industry will probably continue to explore the potential of the reduced spacing.

In 1977, Vandergriff started work at both Elbow gin and J.G. Boswell Co. on possible ways to improve the capacity of the 12" saw gins. The conclusion had been reached that if signficant capacity increases were to be attained it would have to come from both removing seed from the core of the seed roll, and closer spaced saws. Experimental work had been done in 1976 at Boswell on a couple of methods of skimming seed from the outer surface of the roll and spilling them out of the gin through the huller breast. This showed considerable promise, but controlling the residual lint proved to be a problem.

The season of 1977 was spent experimenting with some crude methods of getting seed out of the core of the seed roll through a tube. Also some work was done on a fabricated narrow rib. The first tube was a piece of five inch aluminum tubing with 1"x6" slots. Driving the tube proved to be a problem and also we were not successful in getting enough seed into the tube.

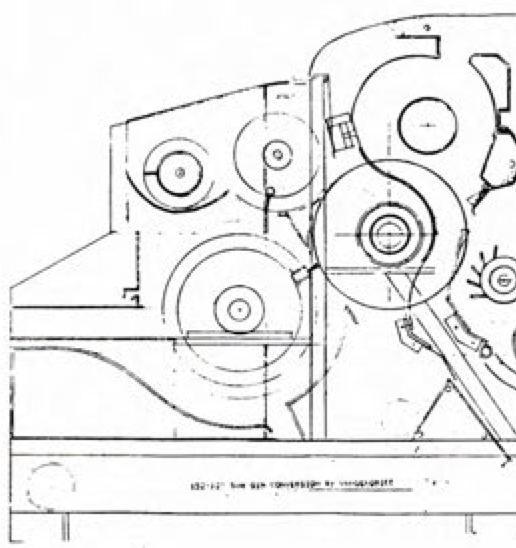
We started the 1978 season with a tube with a conveyor in it but this proved to be complicated mechanically for our resources so we went back to the idea of getting the seed into a tube and conveying them out by air. We found that PVC pipe was easy to work with and by the end of the 1978 season we felt we had learned enough to produce a production model for the 1979 season.

After many trials and tribulations we got stainless steel perforated metal tubes rolled, welded and straighhtened. These were sixteen gauge with three eight inch holes. They were approximately five inches in diameter. Getting these mounted through the heads of the old 120-12" saw CGC gins with the cast iron saw bearing housing with the breast support track on top of it took some doing. How did it is probably of not much interest to you, but we did get it done on two stands.

They operated relatively trouble free and the results were well beyond anyone's expectations. For that seventy day season those two stands ginned 19,941 bales for an average of 278 bales per day.

These gins were equipped with 75 hp motors and the saw shaft speed was increased during the season to 830 rpm.

The original seed tubes at Elbow, along with bearings, blowers and other components on the two gin stands have now operated through the 1985 season, a total of seven seasons. In 1981 tubes were added to two more stands. In the meantime Hot Shelf Dryers were added along with other improvements, which made possible the use of more of the capacity of the six gin stands. By 1984, the plant capacity had reached a maximum of about 1,000 bales pef day with a season average of around 850 bales per day.



THE ONE HUNDRED FIFTY TWO SAW GIN

We had been aware all along that we were leaving more lint on the seed than was desirable, although residual lint tests showed them to be competitive. The most logical approach to improving this situation would be to go to a closer saw spacing. Keep in mind that we were still operating the 120 Saw Gins with the .787" saw spacing. We had continued our efforts to develop a fabricated rib that would permit us to close up the saw spacing. Finally we decided to try to adapt an existing rib having a spacing of about five eighths of an inch. This worked out to permit us to use 152 saws in the frame of the old 120 saw gin. After considerable engineering effort we were able to get this rib located so that we would have the proper rib-saw tooth relationship. The cross sectional view of this gin is shown on the following page. No change was made in the seed tube components. A slight change was made in the top roll box scroll to accommodate the relocation of the upper end of the new ginning rib.

Some vanes were added to the lower front of the roll box where the seed fingers would normally be, and the seed fingers could still be used if desired. These vanes served to aid in breaking the bottomn of the seed roll as it makes the turn, since the closer spaced saws tend to hold the roll up as it makes contact with the saws. These vanes also aid in the selectivity of the seed from a residual lint standpoint.

Note that the huller ribs are merely short pieces of three sixteenth inch flat bars with one forty-five degree break. The space between the upper end of the flat bars and the bottom of the plate holding the vanes permits a free flow of the cotton into the seed roll.

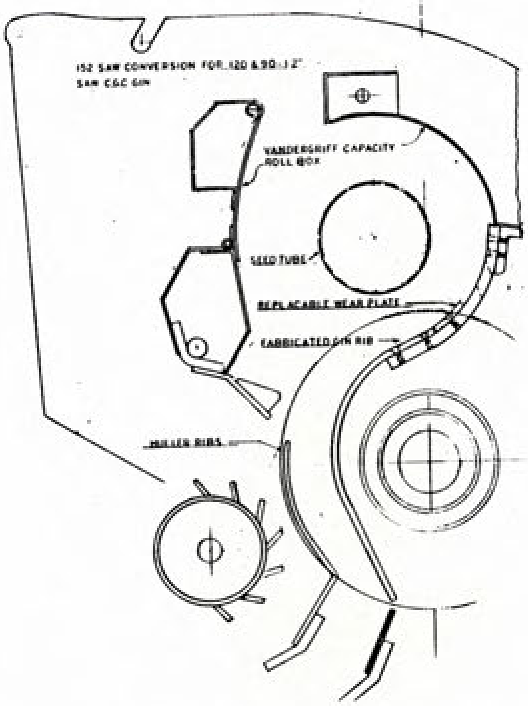
We got a set of the necessary parts made up in time to install them on one stand late in the 1984 season. These parts included new ginning ribs, new top and bottom rib rails, new fabricated huller ribs and the lower huller rib rail, a new saw shaft, saws and space blocks, and a new top roll box scroll.

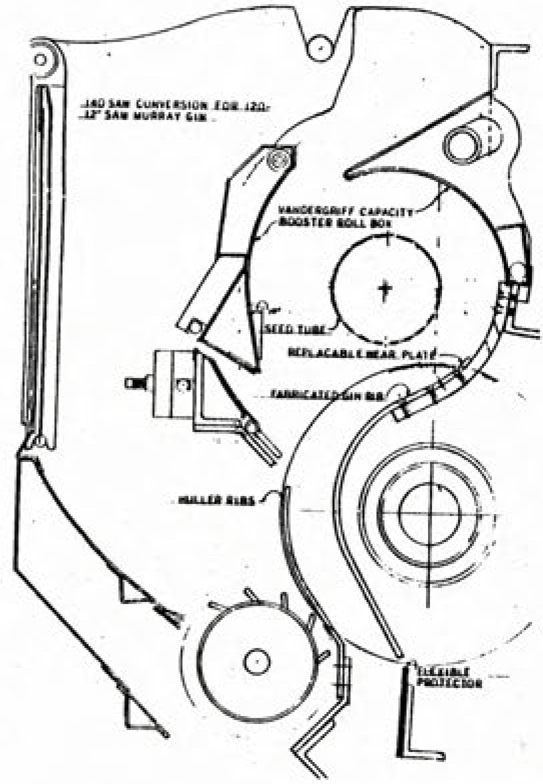
The gin was put into production with absolutely no problems. It performed up to 10 bales per hour with a 75 hp motor on the saw shaft, and the residual lint was at least one and one half percent less than before the conversion.

We did not change the angle of the Vandergriff roll box fronts, which are still twenty degrees off vertical, however with this saw spacing we will get better results with a ten degree approach angle.

We made no change in the Model 30 Huller front of the gin.

This performance justified the conversion of the other five stands for the 1985 season. If you have any questions about what kind of problems we had, I think they can be answered by recapping the ginning record for the





season. In 78 days, 67,600 bales were ginned for a daily average of 866.67 bales per day. This is an average of 36.1 bales per hour for every hour of 78 straight days. The best 24 hour run was 1,042 bales, for an average of 43.4 bales per hour for the entire 24 hours.

Keep in mind that these gins are 1959 Models, and we believe that with the modifications we have made they are about competitive with any gins in use today, new or old. The fact that two of these six stands do not have seed tubes may be of some interest to the reader. The conversion procedure for these is exactly the same as those with the tubes. The operating results are very good, except of course, at a lower capacity. How much less? Probably two bales per hour.

The plant does not gin modules. The cotton all comes into one 8 foot wide separator, then into a 6x12 Hot Shelf Dryer, a 10 foot-6 cylinder cleaner, another 6x12 Hot Shelf Dryer, and then splits into two lines. The original two sets of 6 foot inclined and impact cleaners are still feeding the distributor.

AMSAC

An Automatic Microcomputer Sensing and Control System to Monitor Choke-Ups in Cotton Gins

by W.A. Supak, Texas A&M University

In 1983, Texas cotton gins processed over 2,300,000 bales of cotton and spent nearly $17 million on processing operations (Agricultural Statistics, 1984). Furthermore, Tony Price of the Texas Cotton Ginners' Association has indicated that during peak ginning periods, Texas cotton gins were maintained at full capacity for only 60% of the time. This by conservative estimates represents a loss in excess of $3 million when an efficiency loss of $1.40/bale is applied (Williams, 1982). These losses are of a substantial magnitude and, in some cases, are resulting in gin closures.

Rising electrical costs play a significant role in the financial difficulties encountered by ginners. The effects are amplified when it is noted that the electrical rates charged to ginners is based on their peak fifteen minute demand period of every month (Parnell and Price, 1985) This charging system implies that one extreme demand period can result in considerable losses.

The primary source of electrical demand within the cotton gin is the pneumatic conveying system. Furthermore, maximum pneumatic demand is encountered not when fans are fully loaded but when blowing air, a situation often occurring during choke-ups. With this knowledge, a logical concept for saving money has been developed - shut the gin down upon detection of a choke-up and reduce the electrical rate being charged each month. This concept was selected as the focus for AMSAC.

Due to the complex nature of this project and time constraints encountered, the scope was limited to a thorough analysis of pertinent factors surrounding implementation of a microcomputer-based control system. Economics, system components, sensor type and location, synchronization of shutdown, and the human factor were all considered. The final goal was to establish a base for further research into the possibility of automatic process control in cotton ginning and hopefully promote technological advancement in cotton processing.

AMSAC DESIGN CRITERIA

In order to approach the problem of designing a control system for cotton gins, it was felt there was a need to establish certain parameters concerning design decisions. Four criteria were deemed critical for the design.

The first of these is that the design should adapt to the ginning operation and its environment. This parameter is of utmost importance in choosing sensing and controlling equipment capable of withstanding the dust associated with ginning and the vibrations found in machinery and ducting. It also has an influence on microcomputer and related component placement.

The next consideration is one of flexibility. Since nearly all cotton gins are different from one another, it seems imperative that the system developed be as generic as possible. Another factor emphasizing flexibility is the acknowledgement that ginners frequently increase ginning capacity by adding machinery. Consequently it is believed that the final product should have the ability to expand with gin growth.

Cost is also included as a parameter. A composite cost analysis to justify that the proposed design be able to pay for itself within a reasonable period of time (five years), has been declared a necessity. Desired also is that the cost analysis include prices for specific components selected through comparison measures as recommended AMSAC equipment.

The last parameter, but one possibly more important that the latter three, is the human factor. Being cognizant of the fact that technology for electronic gin control has been in existence for some time, care was taken to examine why similar systems were not being utilized. It was deduced that this denial is the result of neglect by those systems to include a means for the gin operator to monitor gin status and manipulate the gin manually. Thus, AMSAC incorporates a microcomputer for purpose of communicating the gin status to the operator. With this addition, ginners will have on hand a tool which allows them to add their own expertise into the AMSAC system with a minimum of training.

AMSAC DESIGN PRINCIPLE

AMSAC operation is intended to improve cotton ginning by combining the benefits of modern technology and human proficiency. This will be accomplished by including a system override accessible by the ginner if so desired. Three levels of system operation are incorporated into AMSAC: smooth, caution, and crises.

A screen display will be present on the microcomputer monitor at all times, purpose being to serve as a constant source of information on ginning status. The ginner can isolate any portion of the gin on the computer to see if there is a problem at a machine or within a duct. During the caution or crisis periods, however, AMSAC alerts the operator of potential problems. The monitor display isolates the point of trouble, and a bell is sounded to warn of impending choke-up. The difference between the caution and crisis levels is that AMSAC does no gin manipulation during the caution period. This allows the ginner to use his own judgement in determining where he can make some minor adjustment within the gin to prevent a choke-up or permit AMSAC to automatically shut the gin down if gin operation worsens to the critical state.

AMSAC operating levels are specified in the system software and are based on the individual parameters being monitored. The individual aspect should be stressed at this point because individual machines will have their own ranges of smooth and problem operation. These ranges must be set by the ginner since he is the person who best knows his equipment.

Through thse means, the "human factor" has been included in AMSAC, not simply to make the system more attractive for those skeptical of sophisticated equipment, but to make for a more complete, better system. A detailed description of AMSAC components and their function will be given in the following sections.

AMSAC COMPOMENTS

Just as the letters in AMSAC stand for, the system is one of sensing and control. To best outline AMSAC components and their function, it is easiest to break AMSAC down into its two distinct phases - sensing and control.

<u>THE SENSING CYCLE</u>

The sensing cycle consists of the collection of signals sent from sensing devices located throughout the gin. The cycle is comprised of the following components:

1. sensing devices,
2. signal transmission wire,
3. voltage to current converters,
4. interface system,
5. microcomputer

<u>SENSING DEVICES</u>

For total gin control, it has been determined that gin parameters of pressure, shaft speed, temperature, and relative humidity must be monitored.

The pressure transducers used will measure air flow through gin ducting. The transducers emit a signal to the microcomputer based on this pressure measurement. The magnitude of this signal is the variable in the software programming which determines AMSAC action. Due to the fact that choke-ups can occur at any number of areas within a gin, a decision has been made to place a pressure sensor in ductwork between all machines.

Shaft speed transducers will operate under the same principle as the pressure transducers. If a choke-up occurs within a machine, the drive shaft will bind and consequently has a reduced speed. Since the machines are the location of most choke-ups, a sensor will be placed on the main driveshaft of every machine within the gin. An indirect advantage of using this many shaft speed sensors is the possible use of the recorded readings in a maintenance program.

Tower driers are to be the location of the temperature sensors. These are incorporated into AMSAC because most gins are already using some form of temperature regulator within their tower driers. By utilizing these sensors, the ginner can be made aware of how his tower driers are heating and if he is losing money by decreasing the cotton grade with too much heat (Griffin, 1977).

Finally, a relative humidity sensor will be located in air ducting before the tower driers and immediately after should the drier have a moisture restoration system. Since the condition of the cotton is so critical for smooth ginning, it is felt that a humidity sensor should be used with the intention that a moisture regulating system could be added.

A better depiction of sensor location can be seen in Figures 2,3. For this typical gin, a total of twenty-four sensors will be implemented. This may see like a large number, but when the low sensor cost, compared to AMSAC cost and the machine wear maintenance benefit from shaft speed sensors is considered, the number is felt essential. It should be added that transducers do not necessarily have to be limited to the selected types. If a ginner desires to monitor other parameters, motor amperage for purpose of motor maintenance perhaps; he should be able to do so with little difficulty.

<u>Signal Transmission Components</u>

Each of the sensing devices described emits a signal in the form of a voltage. These signals must travel through long distances of signal wire (22 to 28 AWG) to eventually arrive at the microcomputer. Several considerations warrant attention in choosing signal transmission components due to this fact.

Since the wire in which the signals are sent has a resistance, voltage drops are incurred during transmission, and these drops increase linearly in relation to the length of the wire. If left unheeded, severe distortion of the signal will occur; and in the case of very small (micro-volt) signals, the message can be completely obliterated.

To remedy this condition, voltage to current converters (current loops) have been implemented. The current loop device used in AMSAC can be the 2B20 produced by Analogue Devices. This model converts the voltage to a 4-20 mA signal. An added benefit of using the 2B20 is that the operator can see whether a low reading is a result of an impending choke-up or a sensor failure. With this choice of transmission, a sensor failure can be detected and replaced immediately, with the control system still in operation.

<u>The Interface System</u>

Before the current signal can travel into the microcomputer for interpretation, it must be changed into digital code. Thus, some form of interface device must be implemented. Since many different sensor lines need to arrive at the computer, the interface system used in AMSAC has to have the capability of multiplexing the signals - sending the signals into the computer in orderly form. Expandibility is also a primary concern in choosing an interface system.

Serving as the interface in the AMSAC system is the Micro-Mac 4000 series by Analogue Devices and distributed by Omega Engineering. It consists of a master board with screw terminal connectors for up to twelve sensors and a variety of expander boards for more sensor connections. AMSAC consists of twenty-four sensors and, thus, requires an expander board - the Micro-Mac 4010. Each board has four plug-in modules which serve as signal conditioners. Since all incoming signals are of the 4-20mA range, only one module model (the OMX01) is utilized. This simplifies expansion and allows for a capacity of 160 sensors if six expander boards are connected in series.

The Micro-Mac interface also provides all multiplexing needs necessary for sequential signal flow to the microcomputer. An added benefit, besides expandibility, is that the Micro-Mac has on-board power supplies to provide all power required by the sensors for their voltage emissions.

<u>The Microcomputer</u>

The AMSAC system utilizes the IBM PC-AT microcomputer with a color display. The reason for the choice of the IBM is its widespread use in industrial applications, and the widespread service available for this particular computer. Another advantage is the fact that so many hardware and software manufacturers make their products compatible with the IBM.

Once the signals from the interface box have been submitted to the microcomputer, the sensing cycle is complete and the control cycle is started.

<u>THE CONTROL CYCLE</u>

The control cycle is the decision-making and action-taking division of AMSAC. It consists of the following components:

1. microcomputer and software,
2. interface system,
3. select (control) lines,
4. decoder/multiplexers,
5. triacs.

The actual method of control in AMSAC is by digital signals rather than voltage signals.

<u>Microcomputer and Software</u>

Once the conditioned signals enter the microcomputer, the software program responsible for deciphering the signals is instigated. The signals are processed into the microcomputer several times per second as the main program calls the individual subroutines. Each signal is then compared to the parameters set within the program.

This is the portion of AMSAC where the gin operator is granted access to information concerning gin status, and following this transfer of information, a coded signal is released to the control cycle containing the message of action or otherwise.

<u>Control Interface</u>

Once the coded signals leave the computer, they are processed through the same interface system as was used in the sensing cycle. With eight digital outputs, a one master board system can send up to sixty-four different messages (easily exceeding the needs of a typical AMSAC system). These messages, expressed in binary code, then leave the interface box via select lines.

<u>Select Lines</u>

The select wires carrying the codes are in the form of a ribbon as seen in Figure 3. This ribbon runs throughout the gin where it is connected with similar lines connecting to the motors (May, 1985).

<u>Decoder/Multiplexers</u>

Decoder/multiplexers analyze the signal for a shutdown message and are individually set to correspond to these messages. In the event that a code sent from the computer matches the setting of the decoder, a charge is emitted from the decoder/multiplexer to its corresponding triac located at the motor.

<u>Triacs</u>

The triac is the on-off relay wired into the power wire connected to the motor. The charge sent to the triac activates the device, at which time, the power circuit is opened and the motor is turned off.

<u>SYNCHRONIZED SHUTDOWN</u>

A word should be mentioned about the manner in which the gin is to be shut down. An instant shutdown of the entire gin is not a desirable feature, since if a machine is shut down while fully loaded and processing cotton, there is a very real possibility that the gin will choke-up immediately upon start-up. AMSAC must have the capability to wait until after a machine has finished processing the cotton within it when the choke-up occurred. This is excluding the piece of machinery experiencing the choke-up and the fans and machines upstream - all of which will be shut down immediately.

AMSAC FEASIBILITY STUDY

The rapid rise in electrical energy costs over the past fifteen years has created a need for effective energy management programs in cotton ginning. AMSAC attempts to satisfy this need by focusing on the pneumatic conveying system - the primary source of energy consumption in gins. Estimates show that when a choke-up occurs and fans are left in operation, power usage increased by 125% (Williams, 1982). This excess consumption is the cost AMSAC is designed to eliminate.

For comparison purposes, the feasibility study conducted makes use of a typical Texas cotton gin selected through analysis of the 1983 Southwestern Public Service energy report. This gin produces 5000 bales per season at an energy cost of $0.10/kw-h. In addition, the gin has an average requirement of 74 kw-h per bale which exceeds by 14 kw-h the consumption of an efficient gin (Parnell, 1985). The critical phase of this study is whether the benefits of implementing AMSAC outweigh the costs. The benefit associated with AMSAC is the difference between the power demand during choke-up and the next highest demand period occurring at start-up. Choke-up peak demand for the sample gin is 1200 kw-h with a start-up surge of 1100 kw-h lasting for ten minutes before a normal consumption rate of 790 kw-h is reached.

Upon making the calculations shown in the appendix, a net savings of over $27,000 per year is seen to result from AMSAC installation. When this savings is extended over a ten year period, a profit exceeding $300,000 is observed. This number has incorporated into it a yearly maintenance cost computed as 10% of the initial AMSAC investment. The payback period for the initial cost of $19,558 is seen to be less than one year.

It may be argued that although AMSAC is saving money, is not the number of shutdowns going to drastically increase with the system in operation? This, however, should not be the case since a study by Gordon Williams indicates that cotton gins are already experiencing downtime every two hours. Also, the ginner does have at his disposal the system override. The override feature allows a minor problem to be fixed without having to shut down the gin.

SUMMARY AND CONCLUSIONS

The AMSAC concept has been proposed as a means of reducing cotton ginning costs by lowering peak electrical demand. This peak demand is commonly associated with increased pneumatic demand during choke-ups; and, consequently, AMSAC shuts down cotton gins upon detection of choke-ups.

Equipment employed to perform this function includes: a microcomputer, an interface board, signal conditioning modules, decoder/modules, triacs, and sensors.

Implementation of this system is estimated to save over $27,000 per year, with a ten-year savings of over $300,000.

For AMSAC to become a reality, further research will be required in the following areas: additional parameters to monitor, ideal sensor location, alternative means of control, physical assembly of AMSAC, and industry acceptance.

Ideally, AMSAC would not simply shut down gin operations but adjust fan and motor outputs to avoid choke-ups. However, the expense associated with such a system and the gin modifications required were of such extremes as to deem this idea infeasible. Possibly, future progress in the ginning industry could change the status of this concept.

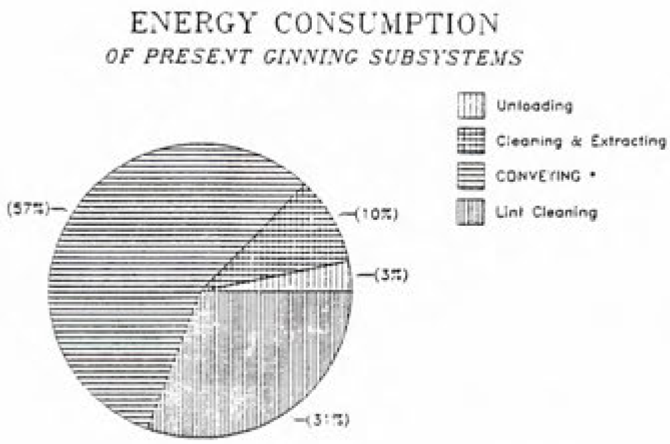
This paper was developed in conjunction with a senior level design class at Texas A&M University. The subject was selected from alternatives presented at the beginning of the fall semester, 1985. Introducing the problem and serving as chief consultant for all project work was Mr. Tony Price, executive vice-president of the Texas Cotton Ginner's Association. The design team consisted of three members, and the final product was a result of equal contributions from the team. Fellow team members were Sherri Clements and Ed Hansalik.

REFERENCES

1. Agriculture Statistics 1984. USDA. p. 77.
2. Analogue Devices, Inc. 1982. Data Acquisition Book, Vol. II.
3. Cantrell, P.F. 1985. Associated Professor of Electrical Engineering, TAMU. Personal Communication.
4. Cerni, R.H. Instruments and Electrical Control Systems. Sept. 1974. 'Transducers in Digital Process Control.' Vol. 37. p. 126.
5. Control & Instrumentation. April 1985. Morgan-Grampion Process Press, Ltd. Great Britain.
6. Design News. January 1985. Cahners Publishing Co., Denver, CO.
7. EDN: Electronic Technology for Engineers and Engineering Majors. May 16, 1985. Cahners Publishing Co., Denver, CO. pp. 179-186.
8. Gibson, J.R. Electronic Logic Circuits, 2nd Ed. 1983. Edward Arnold Publishing Co. pp. 59-65.
9. Griffin, Anselm C. Jr. Cotton Ginner's Handbook. July 1977. 'Cotton Moisture Control.' pp. 13-17.
10. Hickman, P. 1985. Personal Communication.
11. Holzer, J.M. and Chace, D.E. Control Engineering. Vol. 16. May 1969. 'The Black Box: Programmable Logic for Repetitive Control.' pp. 61-65.
12. I&CS: The Industrial and Process Control Magazine. August 1985. Chilton Publishing Co. 58(9):57.
13. IEEE Press. Minicomputers: Hardware, Software, and Applications. 1972.
14. Jones, Thomas H. Electrical Components Handbook. 1978. Reston Publishing Co. pp. 182-250.
15. Langdon, Glen G. Jr. Logic Design - A Review of Theory and Practice. 1974. Academic Press.
16. LePori, W. 1985. Associate Professor of Agricultural Engineering, TAMU. Personal Communication.
17. May, D.A> 1985 Electrical Engineer. Personal Communication.
18. McCaskill, O.L. and Baker, R.V. Cotton Ginner's Handbook. 1977. 'Fans and Piping.' pp. 57-63.
19. Miller, B.E. 1985. Cotton Gin Simulation/Management. Undergraduate Thesis. Texas A&M University, College Station, Texas.
20. Norris, B. Texas Instruments: Electronic Series. 1976. Electronic Power Control and Digital Techniques. McGraw-Hill Publishing Co.
21. Parnell, C.B., Jr. 1985. Associate Professor of Agricultural Engineering, TAMU. Personal Communication.
22. Price, Tony J.H. 1985. Texas Cotton Ginners' Association. Personal Communication.
23. Searcy, S. 1985. Associate Professor of Agricultural Engineering, TAMU. Personal Communication.
24. Sensors: The Journal of Machine Perception. April 1985. 2(4):23.
25. Sissons, T. 1985. Hockley County Gin Manager. Personal Communication.
26. Sorenson, J.W. and Parnell, C.B., Jr. 1985. Agricultural Processing Technology. Kinko Copies.
27. Southwestern Public Service. 1983. Summary of 1983 Southern Division - All Electric Gin Report.
28. Tedeschi, F.P. How to Design, Build, and Use Electronic Systems. 1981. Tab Books, Inc. pp. 196-212.
29. Willcutt, M.H. Cotton Gin Operational Efficiency Measurement Via a Microprocessor-Controlled Data Acquisition Unit. 1978. Transactions of the ASAE.
30. Williams, G.F. 1982. ESIM: An energy-based cotton ginning simulator. Master's Thesis. Texas A&M University, College Station, Texas.

EQUIPMENT SPECIFICATIONS

SENSORS	
Pressure	- Omega PX 126-005D-V, silicon transducer, 50 mv output.
Shaft Speed	- Cole-Parmer T-8201-14, proximity transducer, 5v output.
Temperature	- Omega CPSS-316-12, copper constantan thermocouple, 20 mv output
Relative humidity	- Thunder Scientific PC-2101, solid
COMPUTER	- IBM PCAT (color machine).
VOLTAGE TO CURRENT CONVERTERS	- Analogue Devices 2B20B, nominal input range 0-10v, 4-20 ma output.
DECODER/MULTIPLEXERS	- Texas Instruments 54/74 Family #150, 1 of 16 Data Selectors/ Multiplexers, 4 input wires.
TRIACS	- Square D Co. or Westinghouse Electric Corp. 4a, 200v/25a 600v.
INTERFACE INPUT/OUTPUT	- Analogue Devices Micro-Mac 4000 (or Micro-Mega distributed by Omega) masterboard, Micro-Mac 4010 (analogue expander board).
INTERFACE MODULES	- Analogue Devices - QMX01 (6).
INTERFACE/SOFTWARE	- Analogue Devices - IBM personal computer software support package AC1822.



* *Conveying may rise to 125% when gin not loaded!*

Figure 1. Subsystem energy consumption.

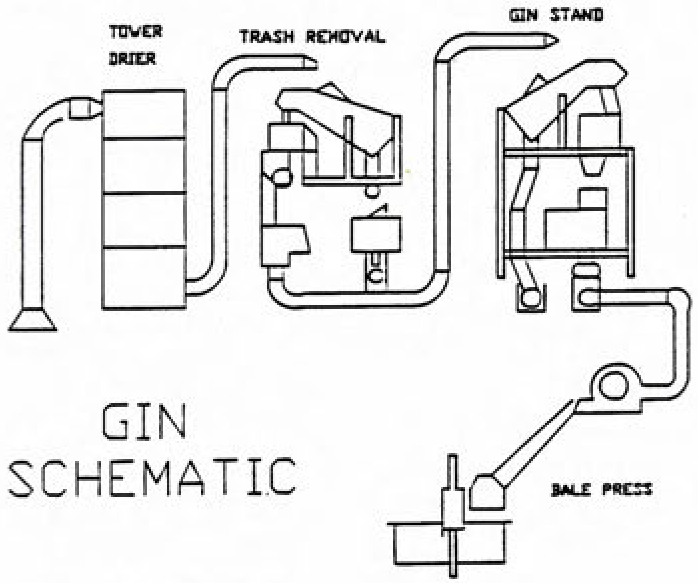


Figure 2. Gin schematic

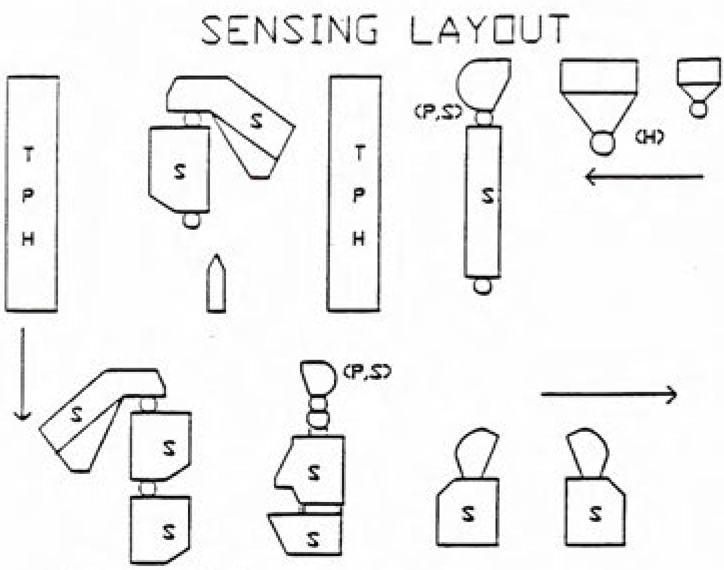


Figure 3. Sensing layout

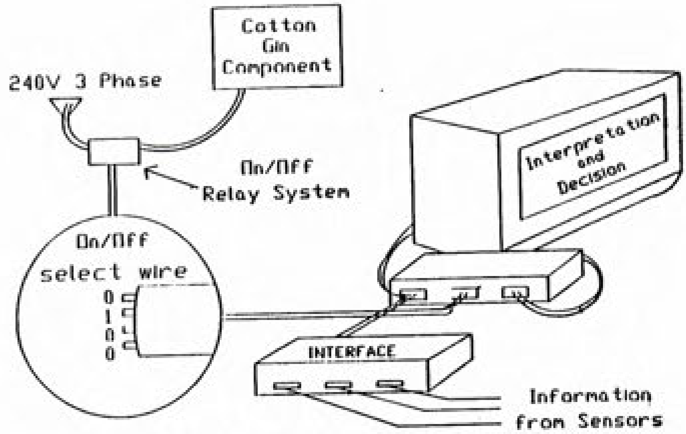


Figure 4. Select wires

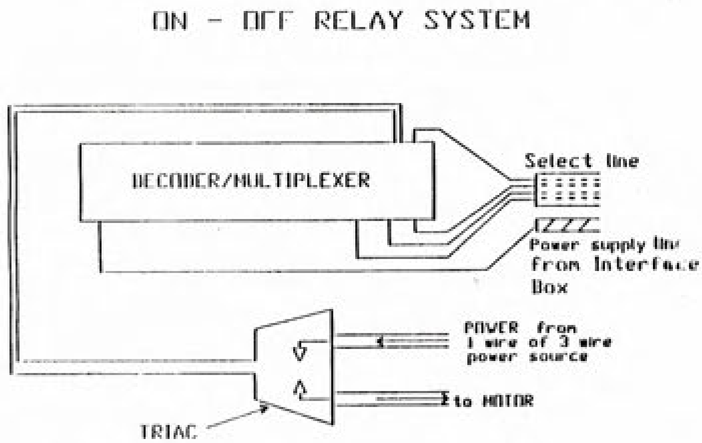


Figure 5. Triac connection.

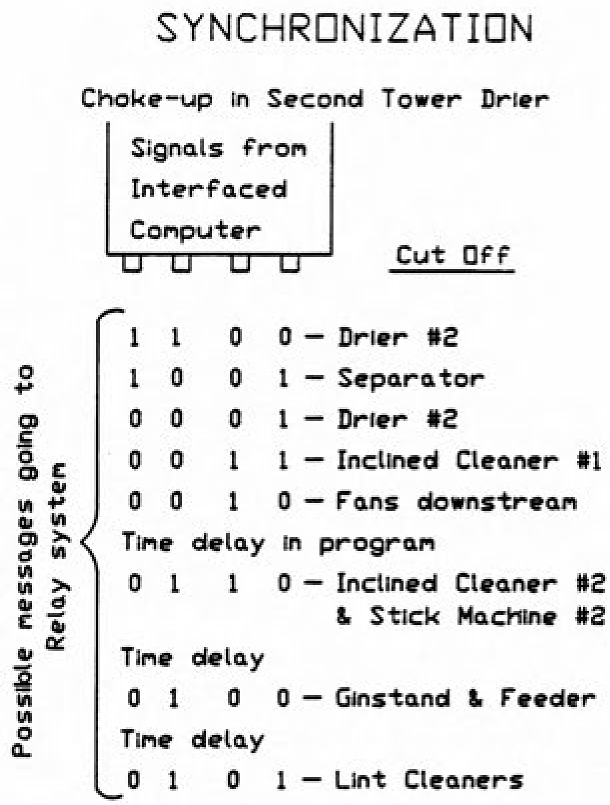


Figure 6. Synchronization example.

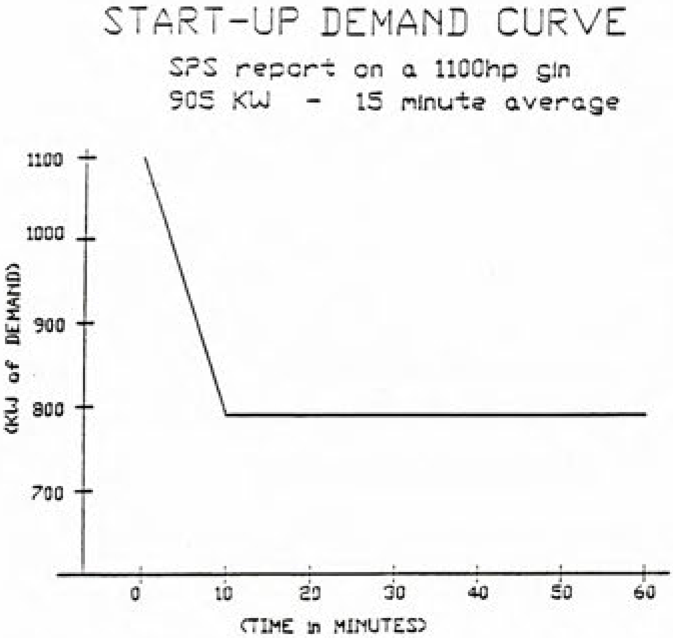


Figure 7. Typical start-up consumption.

AMSAC GINNING SYSTEM

AVERAGE START-UP DEMAND (FROM FIG. 6)	946 KW/H
NORMAL DEMAND	792 KW/H

(946 KW/H) X (10 min) / (60 min/hr) =	157.67
(792 KW/H) X (5 min) / (60 min/hr) =	66.0
	223.67
four 15 min. periods/hr	X 4
	894.67
$ .10 / kwh	X 0.10
	89.47
hrs / ginning season	X 906
⟶ COST/YR	$81059.82

PRESENT GINNING SYSTEM

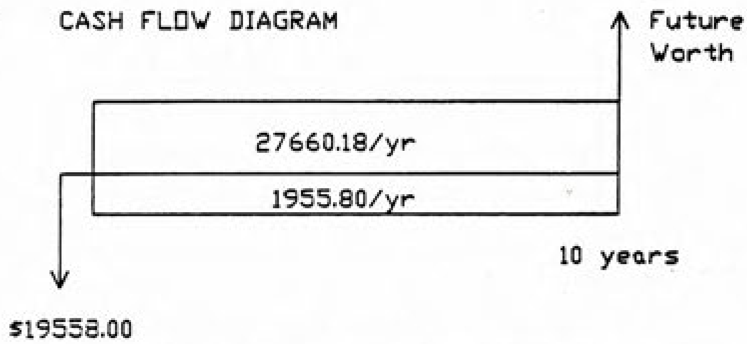
CHOKE-UP DEMAND	1200KW/H
(1200 KW/H) X (15 min) / (60 min/hr) =	300
	X 4
	1200
	X 0.10
	120
	X 906
⟶ COST/YR	$108720.00

Figure 8. Cost comparison.

COMPONENT	NUMBER	COST
Sensing Devices		
Pressure Transducers	(9)	$369.00
Thermocouples	(2)	56.00
Humidity	(2)	200.00
Angular Shaft Speed	(10)	640.00
Cable	(1000ft)	80.00
Multiplexer Connections	(8)	320.00
Triacs	(15)	23.00
Data Selector/Multiplexer	(15)	80.00
Circuit Loop	(10)	560.00
Analog/Digital Interface	(1)	3910.00
Microcomputer	(1)	8000.00
Inplementation		5320.00
	TOTAL ---	$19,558.00

Figure 9. AMSAC system cost.

CASH FLOW DIAGRAM



F = -19558 (F/P,7,10) + 27660.18 (F/A,7,10)

F = $343680.50

Figure 10. 10-Year return on AMSAC investment.

THE INTRODUCTION OF THE MULTISAW LINT CLEANER

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Abstract

Due to the concern from the Ginning Industry of an increase in bark and grass reductions, along with poor grades, Horn Gin Machinery realized the need for a new Lint Cleaner which would increase the cleaning efficiency without affecting overall turn-out. The development of the Multisaw Lint Cleaner began in the fall of 1981 with the same basic concept as a saw type Lint Cleaner, with the addition of a second saw cyulinder. After 2 1/2 years of research, in April 1984 the first unit was field tested, and since then approximately 200,000 bales have been processed on 37 machines with the current season not yet complete. Performance tests indicate outstanding results without damaging the fiber quality below present levels which are now being accepted from conventional tandem lint cleaning systems.

Introduction

Cotton gins have been using Lint Cleaners out of necessity since the early 19050's. The gins must be able to process the fiber in such a way as to bring the producer the highest price for his product. Marketing trends have fluctuated, moving the premium prices paid for certain grades up and down the scale each year. Considering the market price and loan prices each year the goal is almost always for the gins to deliver the best grade possible to give the highest return to the producer. The need for a better lint cleaner led Horn Gin Machinery to develop a machine to achieve the best grade possible, while not lowering turnout and not affecting the quality of the fiber. In April 1984, the first unit was successfully field tested and since then approximately 200,000 bales have been processed through 37 machines. The basic operation, important features, general performance characteristics, and tests and results forthe Multisaw Lint Cleaner are presented here to help define the overall performance.

Basic Operation

The Multisaw Super "86" Lint Cleaner basically combines two conventional stages of lint cleaning into one machine with the addition of several new cleaning features. The fiber is prepared for the saw unit in exactly the same way as previous Horn Lint Cleaners, by passing through a condenser which forms a batt of cotton. The cotton enters the saw unit and is pulled under a feed bar arrangement and onto the top saw cylinder. Seven grid bars are placed opposing the top saw and handle the fiber in the same manner as five grids have in the past. This closer setting between grid bars allows less fiber to be lost without sacrificing cleaning efficiency. After the cotton passes around the top saw, the fiber is transferred to the bottom saw cylinder and seated to the saw by a patented transfer arrangment. As lint is passed from the top cylinder to the lower cylinder, slightly higher rim speed on the lower cylinder enables the fiber to thin out and is theoretically turned over to gain more exposure to the cleaning points. The cleaning section on the bottom saw contains the equivalent of six grid bars and incorporates three combing bars to facilitate the removal of bark and grass. Once the fiber leaves the bottom saw it is doffed with a brush cylinder and is removed from the machine. The Brush Chamber was redesigned from our old style lint cleaner to better doff the saw and virtually eliminates recirculation on the bottom saw and brush cylinder.

Located behind the top saw cylinder is a suction nozzle which removes any fiber that remains on the saw past the transfer point. This lint is returned into the system through the inlet hood on the condenser. An analysis on this fiber shows that it is usable fiber but only consists of less than 1% of all the cotton processed. The fiber return nozzle also keeps this lint from building up behind the feed works and causing potential problems if pulled through into the saw.

Trash particles removed by the machine are pulled through two separate trash hoppers, one off of the top saw and one off the bottom saw. A double 30" fan is supplied to pull from these hoppers to obtain approximately 3,000 CFW on each side, to have adequate air wash on the grid bars. This increase in air velocity helps keep trash from beging pulled back into the cleaned fiber.

Important Features

During the research and development stage of the Multisaw Lint Cleaner, as mentioned earlier, the main objectives were to improve cleaning efficiency and minimize energy cost while keeping the installation as simple as possible. When the finished product was complete the result was a lint cleaner that met and exceeded all its expectations. The capacity of the Multisaw remained equal to previous Horn Lint Cleaners, 10-12 bales per hour on a single unit. The physical dimensions of the machine remained approximately the same with the addition of 2' - 7" to the overall height of the saw unit. The Multisaw uses the same condenser as previous lint cleaners which bolts directly to the saw unit rather than using common legs to support both units. The Mulitsaw can easily be adapted to present systems both behind the gin stand or in a battery installation. In the event the Multisaw replacing two conventional lint cleaners, there will be a decrease in the amount of sheet metal required due to only one exhaust fan, one by-pass valve, and being able to be positioned closer to the lint flue due to having only one machine. With only one exhaust fan for two stages of cleaning, there will also be a decrease in pollution control devices as required for a particular area.

Comparing horsepower requirements of two stages of lint cleaners to the Multisaw, each having the same capacity, results in a net savings of 25 hp for picked cotton areas and 35 hp in stripper cotton areas (Table 1).

Maintenance of the Multisaw Lint Cleaner has proven to be less than tandem lint cleaning due to only one condenser and feed works and one vane axial fan. With only one machine to clean and service during the season opposed to two machines, more time may be given toward making the Multisaw operate more efficiently.

Additional features of the Multisaw include a variable speed drive to maintain proper batt thickness on the condenser. A low speed sensor device is mounted on each machine to monitor saw speeds and drop out the control circuit in the event of a drop in cylinder RPM due to overloading or voltage drop. There is also a time delay built into the condenser motor which allows the saw unit to reach full speed before the feedworks start. All of these electrical connections are easily made in a control box mounted on the front of the machine with only 12 control wires running from the console and starter panels.

Incorporated in with the variable speed drive is an emergency stop device which will brake the feed works and shut off power to the lint cleaner motors in the event of a person being pulled into the top 6" rollers. A kickout bar is placed across the front of the condenser and activates a switch and brake to prevent the feed rollers from continuing to rotate. The saws and brush will then coast to a stop and enable the ginner to correct the problem, reset the emergency stop, and continue operation.

Performance Characteristics

Lint cleaner perforamcne can be discussed in a variety of ways, and is focused primarily at three major groups. Producers, gins, and textile mills each have different objectives all concerning the end result. While gathering information on the Multisaw Lint Cleaner, data was obtained to show each of these groups how the performance characteristics are beneficial. Tests were conducted under controlled conditions at the factory and also during normal ginning. After almost two complete seasons, data has shown substantial improvements in grades based on county averages against gins within those counties. Results of tests comparing tandem lint cleaning to a single Multisaw System, show on the average equivalent or better grades by the Multisaw. Spinning tests conducted on cotton from stripper and picked cotton areas, comparing tandem lint cleaning, Multisaw, and even one lint cleaner before a Multisaw, show only slight differences in spinning performance with no set pattern, better or worse. After approximately 200,000 bales have been processed through Multisaw lint cleaning systems, actual operating performance has been exceptional. With machines running in every major cotton growing area, each installation has proven to help increase the producers price, give the gins competitive grades and turnout, and not affect the fiber quality delivered to the mills.

Tests and Results

Specific tests have been made and data has been gathered from various gin locations. The purpose of these tests are to analyze the performance characteristics as outlined before. Due to the nature of all gin installations having unique differences, tests were chosen and conducted at gin installations which were best suited to obtain the most accurate results possible.

Comparative Testing

The gin most suited for a comparison test between tandem lint cleaning vs. a Multisaw Lint Cleaner was Elbow Enterprises, Visalia, California. This particular installation has a split stream overhead feeding a double battery gin. One press has tandem lint cleaning, the other has Multisaw Lint Cleaning with the option of three stages. All of the lint cleaners in the gin are Horn Gin Machinery equipment. Comparison tests of cleaning efficiency were made using the same load of cotton and samples were taken simultaneously on both sets of lint cleaners. Four samples per bale were pulled from four bales before, during, and after tandem lint cleaning, and also from before and after the Multisaw Lint Cleaner only. All the fiber testing was conducted by the Texas Tech University Textile Research Center, Lubbock, Texas. The before samples were all averaged together giving 32 replications and the after samples were averaged with their respective groups of 16 samples each. The results of the HVI Data and Shirley Analyzer test are listed and the differences between the Multisaw Lint Cleaner and tandem lint cleaning show no significant difference at the 5% level (Table 2). Staple remained exactly the same after processing through a Multisaw Lint Cleaner (M/S) and Tandem Lint Cleaning (TLC). Uniformity Ratio decreased from 83.23 before L/C to 82.35 and 82.21, after TLC and M/S respectively, again showing no significant difference between the methods of processing. Strength increased from before L/C to after TLC .14 G/Tex, but decreased .41 G/TEX from before L/C to after M/S. Micronaire values after M/S were higher than TLC, 4.12 opposed to 4.04, each of these slightly lower than the initial 4.16. The Grade Index values showed 94.75 for before L/C, 98.38 for TLC, and 100 for M/S. The percent non-lint figures follow a similar pattern, 4.32% before L/C, 1.77% after TLC, and 1.70% after M/S. The percent short fiber results were taken from the spinning test samples and are only from a one sample test, and therefore do not reflect any averaging. These show percent short fiber after TLC 14.6% less than 1/2" in length, and after M/S only 11.0% less than 1/2" in length.

Spinning Data

Spinning performance tests were also conducted at Elbow Enterprises. The spin test samples were pulled just prior to the samples taken for the comparative test. Three spin test samples were taken, utilizing each option available at that particular gin. One sample after only a Multisaw Lint Cleaner, one sample after one single lint cleaner before a Multisaw Lint Cleaner and one sample after two stages of lint cleaning. The results for each test are listed in tables 3, 4, and 5 respectively. These spin tests were also conducted by Texas Tech, and were set up to best typify a normal textile mill spinning operation. Upon completion of spinning all three samples, no preference of one particular method of lint cleaning was expressed by the operators, with no apparent differences in spinning performance. While conducting these tests the Textile Research Center had no indication of how each of the three samples had been processed or where they were taken. The comparison between the three sets of results can only be analyzed by experts from the textile industry. If any conclusions can be made, it can only show the differences between the three samples follow no set pattern, and that if anything the three stages of cleaning, with one single saw lint cleaner with a Multisaw Lint Cleaner has no more effect on spinning than two conventional stages of lint cleaning.

Other spinning test and fiber testing have been conducted since early development of the Multisaw in order to determine the effects on strength, length, neps, uniformity, short fiber, etc. Early tests were conducted to show difference in each of these categories before and after the Multisaw Lint Cleaner. Identical spinning test samples were sent to Clemson University School of Textiles and to Texas Tech and tests were run as close to the same as possible. At this point differences from before and after showed little significance and no standards had previously been established to help analyze lint cleaner effects on spinning peformance. This was the main reason for running the tests on the cotton taken from Elbow Enterprise through three different cleaning systems.

Lint Cleaner Waste

When discussing lint cleaner waste the terms fiber loss and turn-out are always mentioned. To give the best indication of the two items mentioned above for the Multisaw, a test was run at New Tex Gin, Plains, Texas. This gin has a new system which gives the option of one, two or three stages of cleaning through Horn Gin Machinery Equipment. The trash from all the lint cleaners are taken through a set of collectors and then pressed into a mote bale with no cleaning on the motes. A single 475 lb. bale was ginned and processed through one Multisaw. The breakdown of the trash for this one bale is outlined (Table 6). The total weight of trash removed from this bale weighed 40.5 lbs. A Shirley Analyzer test was run on this sample of trash and showed 24.8 lbs. of pure trash and 15.7 lbs. of lint. A Peyer AL101 Short Fiber Test was run on the 15.7 lbs. and showed only 1.6 lbs. of lint out of the total trash removed from that bale was the staple length or longer. This helps document the lint savings of the Multisaw Lint Cleaner and also shows a cleaning efficiency of 70.24%. The efficiency is figured as a ratio of the non-lint content removed from the sample to the non-lint content as it enters the lint cleaner.

Actual Gin Performance

Success of the classing office is one true indication of the effectiveness of a lint cleaning system. Shown in Table 7, are six weekly totals from the Lubbock USDA Classing Office and also the same weekly totals from Lubbock Cotton Growers (LCG), Lubbock, Texas. This six week ginning period reflects approximately 12,000 bales ginned at LCG. The percentage of bark reductions for the first five weeks show LCG to be 10% below the average for the Lubbock Classing Office. The grade percentages shown for the two major grade categories this season reflect LCG having a higher percentage of Strict Low Middling Light Spot (42) and a lower percentage of Low Middling Light Spot (52) than the classing office average.

During the same six week period, figures in Table 8 show the comparison of Mesa Gin, Lamesa, Texas to the weekly totals from the Lamesa USDA Classing Office. The grade distribution for Mesa Gin shows the majority of grades falling into the Middling Light Spot (32) category with the remainder primarily in the Strict Low Middling Light Spot (42). The averages from the classing office show very few Middling Light Spot (32) with the majority falling into the Strict Low Middling Light Spot (42) and Low Middling Light Spot (52) categories.

Both of these gins have Multisaw Lint Cleaning Systems which help keep them every competitive in their areas. Analysis of the tables show each gin having lower bark percentages, lower average trash indexes, and having higher percentages in the preferred grade categories.

Summary

The Multisaw Lint Cleaner was developed to meet the needs of the industry and utilize all possible features which could be incorporated to make this machine as efficient as possible. By using one condenser, and two saw cylinders, grid bar configurations, combing bar arrangements and a special transfer and seating technique, this new lint cleaner can handle adequate capacity and deliver premium results. Test results show increase in grades of gins with these lint cleaners, along with very small amounts of usable fiber loss. Spinning data shows the Multisaw does not reduce the fiber qualities which are important to textile mills no more than conventional tandem lint cleaning.

Horn Gin Machinery would like to express appreciation and special thanks to the following individuals who have cooperated in the accumulation of data during the past two years. Texas Tech University Textile Research Center, Jim Parker, Harry Arthur, Edwin Foster, and Harvin Smith; Clemson University School of Textiles and Clarence Rodgers; Elbow Enterprises and Bob Faris; Lubbock Cotton Growers and Gene Beck; Ocho Gin and Wayne Mixon; Mesa Gin, Jerry Harris and Ron Brown; New Tex Gin and Gale Craft; and Jerry Hartman, Producer, Plains, Texas.

Table 1. Comparison of Horsepower Requirements

	Tandem Lint Cleaners	Multisaw Lint Cleaners 1/
Saw Unit)		1-40 Hp.or 50 Hp.
Condenser)	2-40 Hp.(1 per mach.)	1- 5 Hp.
Trash Fan)		1-20 Hp.
V.A.Fan	2-20 Hp.(1 per fan)	1-20 Hp.
Total	120 Hp.	85 Hp.or 90 Hp. 1/

1/ 40 Hp. for stripper areas, 50 Hp. for picker areas.

Table 2. Fiber Quality Comparison 1/

Measurement	Before 2/ Any L/C	Tandem 3/ Lint Cleaning	Multisaw 3/ Lint Cleaner
HVI DATA			
Length, in.	1.15	1.14	1.14
Uniformity Ratio	83.23	82.35	82.21
Strength,G/Tex	28.87	29.01	28.46
Micronaire Value	4.16	4.04	4.12
Grade Index	94.75	98.38	100
Non-lint content,%	4.32	1.77	1.70
% S.F.less than 1/2" 4/	N.A.	14.6	11.0

1/ Same Cotton, identical conditions, ginned at same location.
2/ Average of 32 replications.
3/ Average of 16 replications.
4/ Results from Peyer AL101, TTUTRC.

Table 3. Spinning Data thru 1 - Multisaw 1/2/

	OE 22	RS 22	RS 30
FIBER DATA			
Micronaire	4.17	4.17	4.17
2.5% Span	1.085	1.085	1.085
Pressley "O" Gauge	99.09	99.09	99.09
Uniformity Ratio	43.6	43.6	43.6
MANUFACTURING			
Opening & Carding Waste	9.50	9.50	9.50
YARN & STRENGTH APPEARANCE			
Pounds	107.04	118.36	84.93
Breakfactor	2,355	2,604	2,548
Yarn Grade	B	C	D
Yarn Appearance Index	110	90	70
YARN EVENNESS			
Uster % CV	15.71	22.38	24.79
YARN IMPERFECTIONS/ 1000 YDS			
Thick	164	1,280	1,921
Thin	27	428	722
Neps	266	586	1,264
SPINNING DATA			
Yarn Count	22/1	22/1	30/1
T.M.	4.81	4.25	4.25
Spindle Speed	-	10,000	10,000
Rotor Speed	55,000	-	-

1/ Spinning Test Performed by Texas Tech University Textile Research Center, Lubbock, Texas
2/ All variations, same cotton, identical conditions, ginned at same location.

Table 4. Spinning Data thru 1 - 86" Lint Cleaner and Multisaw 1/2/

	OE 22	RS 22	RS 30
FIBER DATA			
Micronaire	4.02	4.02	4.02
2.5% Span	1.075	1.075	1.075
Pressley "O" Gauge	99.18	99.18	99.18
Uniformity Ratio	42.5	42.5	42.5
MANUFACTURING			
Opening & Carding Waste	9.32	9.32	9.32
YARN STRENGTH & APPEARANCE			
Pounds	108.27	115.82	85.90
Breakfactor	2,382	2,548	2,577
Yarn Grade	B	C	D
Yarn Appearance Index	110	90	70
YARN EVENNESS			
Uster % CV	15.70	22.35	24.97
YARN IMPERFECTIONS/ 1000 YDS			
Thick	138	1,244	1,951
Thin	28	451	809
Neps	218	453	1,191
SPINNING DATA			
Yarn Count	22/1	22/1	30/1
T.M.	4.81	4.25	4.25
Spindle Speed	-	10,000	10,000
Rotor Speed	55,000		

1/ Spinning Test Performed by Texas Tech University Textile Research Center, Lubbock, Texas
2/ All variations, same cotton, identical conditions, ginned at same location

Table 5. Spinning data thru Tandem Lint Cleaning 1/2/

	OE 22	RS 22	RS 30
FIBER DATA			
Micronaire	4.07	4.07	4.07
2.5% Span	1.083	1.083	1.083
Pressley "O" Gauge	98.91	98.91	98.91
Uniformity Ratio	43.8	43.8	43.8
MANUFACTURING			
Opening & Carding Waste	9.09	9.09	9.09
YARN STRENGTH & APPEARANCE			
Pounds	110.36	117.54	88.66
Breakfactor	2,428	2,586	2,660
Yarn Grade	B	C+	D
Yarn Appearance Index	110	100	70
YARN EVENNESS			
Uster % CV	15.60	21.31	23.65
YARN IMPERFECTIONS/ 1000 YDS			
Thick	153	1,032	1,685
Thin	24	313	540
Neps	243	464	1,063
SPINNING DATA			
Yarn Count	22/1	22/1	30/1
T.M.	4.8	4.25	4.25
Spindle Speed	-	10,000	10,000
Rotor Speed	55,000	-	-

1/ Spinning Test Performed by Texas Tech University Textile Research Center, Lubbock, Texas
2/ All variations, same cotton, identical conditions, ginned at same location

Table 6. Breakdown of Trash Content

Bale Weight	475 lbs.
% Non Lint Before Multisaw	8.40% or 39.9 lbs.
% Non Lint After Multisaw	2.50% or 11.8 lbs.
This shows a removal of 28.1 lbs. of non lint	
Total Trash Weight - 40 1/2 lbs.	
% non lint of trash	61.26% or 24.8 lbs.
% of lint in trash	38.74% or 15.7 lbs.
Fiber length 1/ breakdown of lint in trash	
Less than 3/8" =	24.7% or 3.9 lbs.
Less than 1/2" =	42.4% or 6.7 lbs.
Less than 5/8" =	55.8% or 8.8 lbs.
Less than 3/4" =	68 % or 10.7 lbs.
Less than 7/8" =	80 % or 12.6 lbs.
Less than 1" =	89 % or 14 lbs.
Less than 1 1/8" =	95.7% or 15 lbs.
Less than 1 1/4" =	99.1% or 15.6 lbs.

Staple Length of Bale = 1.0175

89% or 14 lbs. of the lint in the trash was less than the staple length

1/ Results from Peyer AL101 Texas Tech University Textile Research Center

Table 7. Lubbock Cotton Growers vs. USDA Classing Office, Lubbock, Texas

	Bark %		Avg. Trash Index		% 42		%52		Staple Avg.	
	USDA	LCG	USDA	LCG	USDA	LCG	USDA	LCG	USDA	LCG
11-8 to 11-14	18	7	4.27	3.98	50	85	39	12	31.8	31.0
11-15 to 11-21	20	11	4.23	4.00	50	79	35	14	32.0	31.2
11-22 to 11-28	19	10	4.16	3.95	53	79	32	10	31.8	31.7
11-29 to 12-6	25	15	4.21	4.05	50	66	38	25	31.9	32.3
12-7 to 12-13	25	15	4.18	4.15	50	64	36	32	32.1	32.5
12-14 to 12-20	26	24	4.17	4.13	51	59	37	37	31.7	32.6

Table 8. Mesa Gin vs. USDA Classing Office, Lamesa, Texas

	Bark %		Avg. Trash Index		% 32		% 42		%52		Staple Avg.	
	USDA	MESA	USDA	MESA	USDA	MESA	USDA	MESA	USDA	MESA	USDA	MESA
11-8 to 11-14	25.5	23.87	4.17	3.65	6.1	43.6	35.2	27	37.7	2.6	32.24	31.28
11-15 to 11-21	29.2	32.0	4.24	3.30	5.4	37.3	32.2	48.1	40.4	6.9	32.22	31.05
11-22 to 11-28	20.4	12.4	4.03	3.10	8.0	56.7	44.1	26.3	30.6	0.4	32.02	31.0
11-29 to 12-6	24.0	14.0	4.13	3.29	4.7	41.5	41.4	33.9	34.3	2.0	32.06	31.52
12-7 to 12-13	15.0	10.0	3.92	3.29	9.4	41.3	50.1	31.4	19.3	3.5	31.85	31.4
12-14 to 12-20	18.0	18.0	3.96	3.43	6.9	32.5	54.8	50.0	21.4	4.6	31.81	31.49

MURRAY CARVER HIGH CAPACITY TWO STAGE SEED CLEANER

By Michael A. Mizer, Director of Engineering
and
Bob Stanley, Director of Domestic Sales

SCOPE

This seed cleaner addresses an area that has long been a problem in the West Texas Region where mechanical stripping and high capacity ginning has made a compromise to quality clean seed that is currently being sold to an oil mill for processing.

The seed cleaner seems to be economically feasible where the ginner is being docked for foreign matter in his seed. This foreign matter consititutes a high percentage of stem, sticks, fly lint, hull pepper, and immature or dead seed (commonly referred to as pops).

In the design of this seed cleaner, sand, rocks, tramp metal and other high density foreign material has been ignored so as not to complicate the objective of removing the highest volume of foreign material, with a minimum of expense for maintenance, space required, and power consumed.

DESIGN AND FLOW

The design of the seed cleaner takes into consideration the space available in a standard gin layout and can be installed anywhere along the main seed and trash conveyors coming from under the gin stands to the seed scales. Please refer to layout drawing #E3-8503020-IM. A simple loop can be provided from the seed conveyor to a mechanical lift where the seed is metered into the seed cleaner and, after cleaning, can be spouted right back into the same seed conveyor down stream. The trash is divided into two groups.

1. Fly lint, hull pepper, light leaf, and pops are air lifted in the first stage and collected commonly over the ginners existing trash bin.
2. Sticks, stems and large trash are conveyed mechanically out discharge spouts to existing trash conveyor normally running parallel with the seed conveyor.

Further consideration has been given to the design of the seed cleaner in the area of dust control, safety, and maintenance. The cleaner comes completely enclosed on all sides except the front using a combination of metal and plastic paneling to protect the worker from rotating and mechancial hazards. This enclosure also promotes drafting of air from the front of the machine to the rear for the requirement necessary on the 1st stage cleaning. This drafting places the entire enclosure in a slight negative vaccum which prevents dust and air borne particles from escaping to the working area.

Eight large moulded inspection doors are located on either side of the cleaner for easy access to the screen and alternate maintenance areas. These doors can be lifted off in tight access conditions. The top enclosure acts as a platform for inspection on the first stage cleaner which mounts above.

OPERATION

The high capacity seed cleaner makes a break with traditional seed cleaning normally found in an oil mill.

The standard practice of seed cleaning normally takes the flow of incoming seed directly to a shaker of some description where screening of sticks, rocks, and large trash are scalped off the top screen. Then the seed is sized and rides across the intermediate or middle area and the small trash, sand and dirt, etc., is evacuated across the bottom. The seed is then fed into an air classification chamber where the light density lint, pepper, hull, leaf, etc. is lifted away from the clean seed.

This standard method of seed cleaning seems to be in wide use and does a remarkably good job but has a major problem in capacity. Since the seed is being fed directly to screens much of the lint and hull has not yet been separated and tends to hair over the screens, rapidly choking the perforations, causing a slow down in capacity and requiring constant cleaning and maintenance.

The new high capacity two stage seed cleaner air washes the incoming seed before the screening stage, tumbling the seed downward through a series of zig zag steps causing turbulence and random activity exposing the seed to a counter current of air that lifts the lint and fines away from the seed. The seed falls downward of its own weight with sticks of equal or heavier density to a chute that splits the stream into two equal portions and is fed onto two shaker trays located one above the other. The perforated metal on the trays allows the seed to fall through to the pan below and is conveyed to the front end for discharge to the clean seed conveyor. The sticks are scalped from the seed and ride across the top of the screens to the front side spouts for discharge into the trash conveyor.

SPECIFICATIONS

The high capacity two stage seed cleaner has successfully run seed at a ginning rate of around 20-22 bales per hour, with seed running approximately 860-950 pounds per bale. This compares to a capacity of around 250 tons of seed per 24 hour day.

The connected H.P. requirements are as follows:

1. 48" Steel Roll Feeder with variable speed control	.75 H.P.
2. Two tray 60" wide Split Stream Shaker	3.0 H.P.
3. #40 Material Wheel Fan at 5000 CFM	15.0 H.P.
4. 12" Rotor Lift Seed Elevator	7.5 H.P.
Total H.P. Connected	26.25 H.P.

FIELD OPERATION

A high capacity two stage seed cleaner was installed at Liberty Co-op Gin in Lubbock, Texas in September of 1985 and was operated for the full ginning season under the direction and supervision of the gin manager, Mr. Wayne Harris.

During the 1985 ginning season Liberty Co-op successfully ginned over 22,000 bales of cotton of which 12,000 bales were processed with the seed cleaner running. To evaluate the effect the seed cleaner had on grade and foreign material, the seed cleaner was shut down periodically and a comparison was made of the analysis at the oil mill, in combination with individual laboratory analysis of samples taken during operation. Through Mr. Harris' cooperation we are able to offer the following information.

1a. With seed cleaner shut off the truck loads of seed being delivered to the oil mill were running 20-22 tons each.

1b. With seed cleaner running the truck loads of seed being delivered to the oil mill increased up to 24 tons per load.

OBSERVATION:

With seed cleaner running an increase of 4,000-5,000 lbs weight increase was obtained on each load, indicating a loss of empty seed (pops), fly lint, and light trash making for a higher density pack.

2a. With seed cleaner shut-off the seed loads were showing dockage of 2-3% per load. With 1% foreign matter allowable with no penalty, this indicated 3-4% actual foreign material.

2b. With seed cleaner running the seed loads were showing lower dockage charges in the 0-1% range. With the 1% allowable foreign matter, this indicated total foreign matter was in the 1-2% range.

OBSERVATION:

With seed cleaner running a decrease of 2-2 1/2% foreign material was removed from seed depending of course on the quality of the incoming seed.

3a. With seed cleaner shut-off the loads were showing seed grades in the 99-100 range.

3b. With seed cleaner running the loads were showing seed grades in the 103-105 range.

OBVSERVATION:

With seed cleaner running an increase of 4-5 points in grade indicates higher oil content which compares favorably with observation 1, indicating the loss of pops, lint, and light trash making the quality of seed and oil content show higher.

ECONOMICS

The following example is presented to illustrate the economic advantage to the gin that may be obtained through operation of the seed cleaner. For purposes of simplification the following assumptions are made:

1) Base seed price is $100 per ton, based on 100 grade seed.
2) Seed weight (after cleaning) is 800 pounds per bale.
3) Gin is paid for "Net Clean Seed" weight (after foreign matter deduction has been made to "Total Net Weight").
4) Gin in this example gins 10,000 bales per year and operates 24 hours per day at a capacity of 15 bales per hour.

	GIN WITH SEED CLEANER	GIN WITHOUT SEED CLEANER
VOLUME	10,000 bales	
	x 800 lbs. seed/bale	
	8,000,000 lbs. seed	
	/ 2,000 lbs/ton	
TONS OF SEED (Clean Seed Wt.)	4,000 tons seed	
BASE SEED PRICE (100 grade)	$ 100/ton	$ 100/ton
SEED GRADE	x 104	x 100
EFFECTIVE SEED PRICE	$ 104/ton	$ 100/ton
TOTAL SEED VALUE	$416,000	$400,000
INCREASE IN SEED VALUE	$ 16,000	

COST OF OPERATION

26.25	HP	Connected Horsepower Load
x .746	KW/HP	
19.58	KW	
x 24	Hours/day	
469.92	KWH/day	Daily Power Consumption
15	Bales/hr.	Ginning Rate-Hourly
x 24	Hrs./day	
360	Bales/day	Ginning Rate-Daily
x 800	Lbs. seed/bale	
288,000	Lbs. seed/day	
/ 2,000	Lbs./ton	
144	Tons seed/day	Daily Seed Volume
469.92	KWH/day	Daily Power Consumption
/ 144	Tons/day	Daily Seed Volume
3.26	KWH/ton	Power Consumption Per Ton
x .07	Cents/KWH	Power Cost
.228	Cents/ton	Power Cost per ton
.228	Cents/ton	
x 4,000	Tons/year	
$ 912.00		Annual Power Cost

CONCLUSION

The above example indicates an increase in revenue to the gin of $16,000, less power costs for seed cleaner operation of approximately $1,000. This $15,000 net revenue increase amounts to $1.50/bale for our fictitious gin. This per bale figure does compare favorably however with figures obtained from Liberty Co-op. Mr. Harris estimates increased revenue of $1.25 to $1.50 per bale from operation of the seed cleaner during the 1985 season. The seed cleaner should enable the ginner to pay a more accurate price to the farmer for cleaner seed at the gin and allow the ginner to deliver a higher quality product to the oil mill. With the higher stick and trash contents in cottonseed we have seen in past seasons, the seed cleaner may be an important addition to the modern cotton gin.